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THE EFFECT OF INDUSTRIAL ARTS ON THE MATHEMATICS AND SCIENCE ACHIEVEMENT OF STUDENTS IN A JUNIOR HIGH SCHOOL

BY

LLOYD S. ROBINSON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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IN

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled THE EFFECT OF INDUSTRIAL ARTS ON THE MATHEMATICS AND SCIENCE ACHIEVEMENT OF STUDENTS IN A JUNIOR HIGH SCHOOL, submitted by Lloyd S. Robinson, in partial fulfillment of the requirements for the degree of Master of Education.

DEDICATION

This work is dedicated to my wife Maisie and daughter Dahlia

ABSTRACT

This study was to ascertain if students who are enrolled in industrial arts simultaneously with mathematics and science, achieved better in these academic subjects. Consequently, the study tested one of the industrial arts objectives which is, "to provide a synthesizing environment for students to apply their academic knowledge in the solution of practical problems." This objective was taken from page 3 of the Junior High School Curriculum Guide for Industrial Arts (1969).

The population for this particular study included two discrete groups of students that were from the same junior high school that was part of the school system of the Calgary Board of Education. Each grade was divided into two groups. One group, the treatment group, represented the students who were enrolled in industrial arts, mathematics and science during the 1981-82 school year. The other group, the control group, did not have industrial arts during the 1981-82 school year, but were enrolled in mathematics and science. The treatment group and the control or non-treatment group in each grade, did the same mathematics and science course prescribed for that grade.

The method employed to select the students to be placed into either the treatment group or the non-treatment group was the registration and option course selection form which was completed by each student prior to the start of the 1981-82 school year. Students were requested to complete these forms and return them to the school. The students who selected industrial arts as one of their option courses were permitted to take the course and were placed in the treatment group. The rest of the student body were designated as the non-treatment group.

The data used in the research analysis was taken from 176 students in the treatment group and 328 students in the non-treatment group. In reference to the grades, the treatment group included 67 grade seven students, 53 grade eight students and 56 grade nine students. The non-treatment group had 88 grade seven students, 112 grade eight students and 128 grade nine students. The treatment was the learning activities which were pursued in the industrial arts program for the grades seven, eight and nine respectively. All industrial arts programs for these students were based on the Junior High School Curriculum Guide for Industrial Arts.

The achievement (reinforcement) in mathematics and science was measured by using the junior high school internal departmental examinations for grades seven and eight; but, for the grade nine, achievement in mathematics and science was measured by using the departmental examinations set by the Calgary Board of Education. The contents for these two courses and examinations were based on the Junior High School Curriculum Guides for Mathematics and Science.

In reference to mathematics and science, two hypotheses were set for each grade. It was anticipated that the treatment groups would achieve a higher mean score than the non-treatment groups on all the examinations.

By using the pretest responses, a T-test analysis was done to determine if there were significant differences between the treatment and the non-treatment groups.

For each grade and each subject, the pretest responses were blocked into three sections; namely, low, medium and high. An analysis of variance was done on the post-test scores in order to determine if there

were significant differences in the treatment and the non-treatment groups. This analysis revealed that the six hypotheses which are on page 24 of this thesis, were rejected.

These results may be due to the culmination of several limitations.

(a) The learning activities in the industrial arts program were not, in some respects, reinforcing the objectives of the industrial arts curriculum.

(b) There was inadequate liaison between the industrial arts teacher and the teachers of mathematics and science.

(c) The sampling technique was not adequate to obtain groups which were relatively homogeneous.

Perhaps this study generated other concerns; therefore, recommendations were made for further study.

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CHAPTER I

THE PROBLEM

INTRODUCTION

The history of industrial arts in the Province of Alberta is approximately 75 years old and can be traced to the Macdonald Training Plan established in 1900 by Sir William Macdonald, a Canadian philanthropist. Macdonald was induced by Dr. James Robertson to spend 1.5 millions of dollars over a period of three years to extend manual training into at least one public school in each province of Canada. According to Chalmers (1967), money from the Macdonald Fund provided salaries, equipment, upgrading and cost of instruction as well as the cost of training teachers. Buildings were the responsibility of the school boards which participated. (p. 204)

Chalmers recorded that event by stating:

> Sir William Macdonald, spent one and one-half millions of dollars on what was this country's first large scale, systematic experiment in vocational education. To demonstrate the importance of manual training, twenty-one centres, . . . and Calgary were selected. (p. 204)

Manual training remained a predominant force in the educational offerings of the province until 1926 when Manual Arts I and II became part of the courses in the secondary schools. This program was in effect until 1938 when the program was broadened and given a name change to General Shop. The General Shop program included instruction in woodwork, metalwork, electricity, automotives, farm mechanics and plastics. At the junior high school level, this program was exploratory

while at the senior high school level there was a definite vocational education bias.

In 1952, the Department of Education personnel made a concerted effort to revise and rewrite industrial arts courses so that they would conform with the philosophy of general education. From these efforts, new curriculum guides were written.

One of the most significant events that impacted on industrial arts was the acceptance by the Department of Education, of the four-phase program for industrial arts which had been proposed by H.R. Ziel of The University of Alberta. When this program was accepted by the Department of Education in 1963, new curriculum guides had to be written. The first of these new curriculum guides was distributed to industrial arts teachers in 1965. The curriculum guides were revised and published in 1967, 1969 and 1976. An integral part of these curriculum guides is the objectives for the industrial arts program. These objectives have been reconsidered each time the curriculum guide was revised.

The Junior High School Curriculum Guide for Industrial Arts (1969) includes seven general objectives for the program. The second of these reads:

> To provide a synthesizing environment for students to apply their academic knowledge in the solution of practical problems. (p. 3)

Implicit in this objective is the fact that learning activities taught in an industrial arts laboratory should reinforce the core subjects such as Mathematics, Science, Language Arts and Social Studies.

When the curriculum guide was revised in 1976, the objectives presented were categorised as follows: Personal Growth, Career Explorations, and Occupational Skills. In turn, there are three general objectives listed under Occupational Skills, the third of which states:

> To provide a technical environment which permits students to synthesize their accumulated knowledge in the solution of practical problems. (p. 2)

A search of the various indices that report the findings of educational research indicates that limited research has been completed on the influence that learning activities in industrial arts had on the scores that industrial arts students made on mathematics and science achievement tests. This paucity of research findings helped to identify a problem that was researchable for this report.

PROBLEM STATEMENT

The major problem of this study was to determine if learning activities in industrial arts had an influence on achievement test scores for mathematics and science for junior high school students enrolled in industrial arts when compared to other junior high school students who were not enrolled in industrial arts but were enrolled in the same courses in mathematics and science.

SUPPORTING OBJECTIVES

The following objectives were written in support of the major problem on this research:

1. To determine if the learning activities in industrial arts that included mathematical concepts were realistic in quantity to reinforce these concepts for this core subject.

2. To determine if the learning activities in industrial arts that included scientific concepts were realistic in quantity to reinforce the concepts taught in this core subject.
3. To determine if the kinds of industrial arts learning activities that purported to reinforce mathematical and scientific concepts will have to be expanded as a result of this study.
4. To determine if district or school designed "Achievement Tests" contained questions, problems or statements that were related to the content of these two core subjects that were purported to be reinforced in an industrial arts setting.

RATIONALE

It is evident from what is published by the Department of Education in the Junior High School Curriculum Guide for Industrial Arts, that one of the major objectives of the industrial arts program should be to reinforce concepts, theories, laws and principles that are taught in mathematics and science courses.

The major reason for conducting this research was to determine if the learning activities in industrial arts taught in a selected junior high school in a large Canadian city did have an influence on achievement test scores for mathematics and science using an achievement test that was designed by either district or school personnel.

A second reason which helped to establish a rationale for conducting this study, was to determine if students enrolled in industrial arts were involved with learning activities that would help to achieve the objectives for reinforcing the academic disciplines listed in the curriculum guide for industrial arts.

A third reason that contributed to establishing a rationale for this study was to determine if industrial arts learning activities that involve mathematical or scientific concepts, theories, laws and principles would need to be revised as a result of the achievement test scores that participating students made on their mathematics and science tests.

OPERATIONAL DEFINITIONS

Researchers in reporting the findings of their investigations use terms that are common to their studies. These definitions normally are operational and have implications for the particular study being reported. The purpose of these operational definitions is to establish a commonality of understanding between the researcher and the reader. For the purpose of this study, the following operational definitions will apply.

INDUSTRIAL ARTS

The definition for the term industrial arts evolved over a period of time and has been stated differently by authors who have written on the theory and philosophy of this subject area. Bonser and Mossman (1923) provided the first definition for the term industrial arts during the first decade of the twentieth century when they wrote:

> The industrial arts are those occupations by which changes are made in the forms of materials to increase their values for human usage. As a subject for educative purposes industrial arts is a study of the changes made by man in the forms of materials to increase their values, and of the problems of life related to these changes. (p. 3)

Feirer and Lindbeck (1964) in Industrial Arts Education, a publication of The Center for Applied Research in Education, presented the following definition for industrial arts:

> is the broad study of the tools, materials, equipment, processes, products, and occupations in industry pursued for general educational purposes in shops and laboratories of schools. (p. 15)

The American Vocational Association (1965) in a publication entitled Industrial Arts in Education provided this definition for the term industrial arts:

> is the study of technology, including industrial tools, materials, processes, products, occupations and related problems. It involves activities conducted in shops, laboratories, drafting rooms and elementary school classrooms. (p. 3)

The American Council of Industrial Arts Supervisors (1963), a division of the American Industrial Arts Association, in Industrial Arts Education stated that the related terms, industrial arts and industrial arts education:

> Describe that part of the total program of education concerned with providing youth an opportunity to study about and to use tools, materials and processes of industrial-technical fields. Industrial arts education is provided at the elementary school, junior high school, high school and college levels. (p. 2)

The Industrial Arts Division of the American Vocational Association in its 1974 publication Guidance for Industrial Arts in General Education revised its 1965 definition for the term industrial arts so that it was more comprehensive:

> Industrial arts education is that field which provides opportunities for all students from elementary through higher education to develop an understanding about the technical, consumer, occupational, recreational,

> organizational, managerial, social, historical and culture aspects of industry and technology. Furthermore, it is a field wherein students acquire industrial-technical knowledge and competencies through creative and problem-solving learning experiences involving such activities as experiments, planning, designing, constructing, evaluating, and using tools, machines, materials and processes. (p. 6)

In their book Managing Multiple Activities in Industrial Education, Silvius and Curry (1971) provided a rather extensive and all inclusive definition for the term industrial arts when they said that:

> Industrial Arts (Education): (1) an area of education dealing with occupational exploration and development as well as socio-economic problems, through experience involvement with a wide range of materials, tools, processes, products, and occupations typical of an industrial society. (2) a phase of the educational program concerned with orienting individuals through experience involvement and study in a technical-industrial society for the purpose of enabling them to acquire broad-based foundational employment skills, to use avocational time more effectively, to have greater appreciation of a material goods culture, and to act more intelligently regarding matters of health and safety, especially as affected by industry. (3) instructional laboratory experiences that provide general educational experiences centered around an interpretation of industry, the industrial and technical aspects of life, as well as orientation in the areas of appreciation, production, consumption, and recreation through actual experiences with industrial tools, machines, materials, and the products of industry. It serves also in providing development and exploratory experiences for occupational guidance purposes. (p. 592)

The 1969 Junior High School Curriculum Guide for Industrial Arts states that industrial arts is the general education aspect of the industrial education continuum. It is general education in that it is not specialized. The 1976 guide published by Alberta Education omits the words "Industrial Arts" and the title of the guide is changed to Junior High Industrial Education Guide, Alberta Education, 1976.

INDUSTRIAL EDUCATION

There are a number of authors who have written books on either the theory of vocational education and industrial arts or the instructional strategies used by teachers in these two complementary subject areas to present instructional content to students.

Included in the books authored by Silvius and Bohn (1961), Silvius and Curry (1961), Roberts (1965), Baird (1972), and Giachino and Gallington (1977) were definitions of the term industrial education.

In Organizing Course Material for Industrial Education, Silvius and Bohn (1961) defined industrial education and emphatically stated that it was to be considered a generic term that was concerned with all areas of education that were designed to meet the needs of industrial technology. According to these authors, industrial education is:

> a generic term in referring to industrial arts, trade and industrial education, industrial training, technical education, apprenticeship, and the offerings of private trade schools. It is concerned with all areas of education designed to meet the needs of industrial technology and develop an understanding of industrial activities. (p. 79)

Roberts (1965), in Vocational and Practical Arts Education presented definitions for each program of study that prepares a learner with the requisite skills to enter the world of work. Among these definitions was one for the term vocational industrial education which included courses that were given in a variety of settings such as: trade schools, technical schools, general purpose secondary schools, and in factories and industrial plants. (p. 285) According to Roberts, industrial education is defined in this way:

> Vocational industrial education, together with general industrial education or industrial arts, and vocational technical education constitute the broad field of industrial education. (p. 285)

Silvius and Curry (1971) in Managing Multiple Activities in Industrial Education presented a definition for the term industrial education that was almost congruent with the definition given by Silvius and Bohn. With slight modification to the definition quoted from Silvius and Bohn, Silvius and Curry defined industrial education as:

> A generic term used in referring to industrial training, vocational-industrial education, industrial arts, technical education, apprenticeship, and the offerings of private trade schools. It is concerned with all education which has been adapted to meet the needs of industrial technology and to interpret industry. (p. 592)

Baird (1972), Contemporary Industrial Teaching: Solving Everyday Problems, made use of a chart to show the relationship that exists between the term "industrial education" and other contemporary terms such as: vocational education; vocational industrial education; trade and industrial education; industrial arts; and technical education. (p. 6) Baird also considered the term industrial education to be generic when he wrote:

> Industrial education [is] a generic term used to encompass all types of education dealing with industry and technology in our society. (p. 6)

The term industrial education was first used in a widely distributed release of Alberta Education in the title of a paper presented by J.D. Harder, Associate Director of Curriculum for Alberta, to a conference of industrial arts and vocational education teachers, held in Red Deer on April 24-25, 1971. The title of that paper was "A Proposal

for Industrial Education." Included in that proposal was the following definition for industrial education:

> A continuum of experiences starting with industrial arts at the junior high school and expanding to the development of skills related to career fields through courses in industrial arts and vocational education, and finally culminating in on-the-job work experience or entry into a post-high school institution. (Harder, 1971, p. 5)

The content of the Handbook in Industrial Education for Guidance to Teachers, Counsellors and Administrators (1979) from Alberta Education, includes the most recent definition for the term industrial education. The Handbook states that industrial education:

> is a program consisting of courses that provides a continuum of experiences, starting with exploratory experiences and activities in the elementary and junior high schools, expanding in the high school to the development of skills in career fields, and culminating in on-the-job experience. (p. 2)

This latter definition is the one that was accepted by the researcher for this study because it is an umbrella term that includes both industrial arts and vocational education.

MULTIPLE ACTIVITY LABORATORY

It is difficult to trace the origin of the term general shop from which the term multiple activity evolved. Silvius and Curry (1971) in Managing Multiple Activities in Industrial Education traced the term general shop to Mays 1950 who called for a program of diversified shop experiences for junior high school pupils. (p. 41) In Mays, the term general shop was most commonly used to designate the organization of a shop where several types of shop experiences were offered under the instruction of one teacher. (p. 141)

According to Silvius and Curry, the much preferred definition for general shop among industrial arts educators in the 1950's was:

> The general shop is a room that has been equipped and organized so that students may participate in various activities and have experiences with a variety of tools, equipment, and materials. (p. 557)

These authors pointed out that when preparing the manuscript for Managing Multiple Activities in Industrial Education it became evident to them that the term "general shop" was no longer adequate and that a more inclusive term was needed. As a consequence of this inadequacy, they formulated the term "multiple activity" and defined a facility designed as a multiple activity laboratory, "a room that has been equipped and organized so students may participate in various activities and have experiences with a variety of tools, equipment, and materials". (p. 558)

An analysis of the definitions for general shop and multiple activity will show that these definitions are congruent and the only change that has been made was that the term multiple activity was subtituted for the term general shop.

According to Silvius and Curry there are two types of multiple activity programs - limited general shop and comprehensive general shop. (p. 558) In describing a limited general shop, these authors wrote:

> In the limited general shop, the approach has been based on activities centered around a basic material, an occupation, or closely related technologies like wood, metal, printing, electrical or power mechanics. (p. 558)

In contrasting the limited general shop with the comprehensive general shop, Silvius and Curry wrote:

> The comprehensive general shop has provided for a number of activities covering various materials and vocations, such as wood, metal, leather, auto mechanics and electricity. The activities have been unrelated, and not built around any one kind of material, technology or closely related cluster as in the limited general shop. (p. 558)

It is evident from these authors, that the facility or the laboratory where industrial arts is taught in the secondary schools of Alberta would be classified by them as a comprehensive general shop or a multiple activity laboratory which is:

> A school industrial laboratory designed and equipped to offer instruction in a variety of industrial or technical areas for breadth or depth purposes in industrial education. It may contain facilities for teaching concurrently, woodworking, metalworking, and plastics technology, or for teaching the variety of instruction essential to some industrial subjects such as metal processing. (p. 594)

The Junior High Industrial Education Guide (1976), an official publication of the Curriculum Branch of Alberta Education, does not define a multiple activity laboratory per se but it does provide a definition for the multiple activity program and approach. According to the Guide:

> The multiple activity program is an organizational device by means of which a variety of exploratory experiences can be presented with a minimum of room and equipment. The laboratory is organized into a number of different sections representing the fields of study. Each section or bay is large enough to accommodate 4 to 6 students. (p. 4)

Although the above definitions for a multiple activity laboratory are from a North American perspective, the definition provided by Alberta Education will be the one used in this study.

ARTICULATED INSTRUCTIONAL DEVELOPMENT (A.I.D.)

Since the advent of instruction sheets in industrial arts and vocational education in the 1920's, teachers of these subjects have attempted to use these instructional materials to either individualize or personalize their instruction. One of the most recent instructional materials to be developed at The University of Alberta was the Pictorial Programmed Instruction (P.P.I.) text. These texts are operation specific and founded on the work of Skinner and Hofer and are based upon the principles of operant conditioning.

According to Preitz (1972) a P.P.I. is defined as a:

> Method of teaching which consists of a series of precise descriptive statements with a supporting photograph for each statement. Both the statements and the photographs are logically and sequentially organized to describe or illustrate sub tasks of an operation or a process that the student is to learn. These statements and photographs are designed to transmit information to the student in the most direct manner possible and require an overt response by the student replicating some type of "hands-on" experience. (p. 16)

These texts, when properly used, are considered as an enabling activity that is self-instructional and supplementary to the instruction of the teacher.

In their joint presentation to the 36th Annual Convention of the American Industrial Arts Association, Preitz and Morris (1974) spoke on "Software Design for Teachers". In discussing the Articulated Instruction Development (AID) booklet, Morris said, "these booklets, although using some of the principles of pictorial programmed instruction, differ slightly in that a product or process is used for instructional content. The AID booklet is product or process specific". (p. 265)

According to Morris, the basic element of an AID booklet was to "show and tell" the "what and how" to a junior high school student as that student proceeds to perform a process or fabricate a product. (p. 265) At that presentation, Morris described the organization of the booklet in this way:

> Format
>
> 5 1/2 x 8 1/4 inch page size
> one picture per pager
> maximum of four lines of script per page
> printed both sides of paper (maximum of 79 pages)
> arrow identification of motion
>
> Content
>
> product or process base
> reading level controlled (what followed by how)
> script in complete sentence
>
> Control
>
> Production Control Activity Record (PCAR) in each booklet
> Procedure Check Points - give non-manipulative directions
> Quality Check Points - require teacher inspection and approval to continue
> Power Equipment Check Points - require teacher approval and possible demonstration prior to continuation
> End of AID Check Point - requires teacher's initials
> AID booklets are color and number coded in accordance with an open-ended classification system. (p. 266)

The purpose for including a definition of the term AID was that this form of printed instructional material was used to supplement the instruction of the teacher in the research school.

INSTRUCTION SHEETS

Instructional materials support the role of the teacher in the teaching/learning environment. The researcher for this study equated

instructional materials with information sheets. Pautler (1971) wrote that information sheets represented one group of the many instructional aids which were used by teachers. This author defined instructional aids in these words:

> Instructional aids are devices of one nature or another that can be used by the teacher in the instructional process. (p. 143)

Giachino and Gallington (1977) wrote that R.W. Selvidge was one of the early pioneers in industrial arts teaching who emphasized the use of instruction sheets. (p. 312) They stated that in general there are five types of instruction sheets: namely the operation sheet, the information sheet, the job sheet, the job plan, and the assignment sheet. (p. 313)

Silvius and Bohn (1976) made reference to the work of the late Professor Selvidge who presented a classification for instruction sheets. These two authors conceded that instruction sheets facilitated individualized instruction and they advocated the use of four types which were: operation sheets, information sheets, assignment sheets and planning sheets. (p. 288)

The Junior High Industrial Education Guide, for 1976 presents this definition for instruction sheets: "These are supplemental teaching materials which contain organized material for the use of individual students." (p. 7) The Guide refers to these four common types of instruction sheets: the operation sheet, the job sheet, the information sheet and the assignment sheet.

Giachino and Gallington (1977) in Course Construction in Industrial Arts, Vocational and Technical Education wrote these definitions for the five types of instruction sheets:

> An operation sheet contains detailed instructions on how to perform a specific operation . . . An information sheet is one which contains the pertinent information students need to know to fully understand their work.
>
> A job sheet contains all the necessary directions for the completion of a job or project.
>
> . . . . . .
>
> A job plan simply lists the essential performance steps without actually telling how the work is to be done . . . . An assignment sheet contains written instructions to guide a student in studying, reading or conducting investigations. (pp. 313-318)

Silvius and Bohn (1976) defined a planning sheet as an available aid to students in developing their own plan for a project, experiment or unit. (p. 288) Their definitions for other instructional materials such as an operation sheet, information sheet or assignment sheet were congruent with the definitions that Giachino and Gallington gave.

The Junior High Industrial Education Guide (1976) presents these definitions for the four types of instruction sheets:

> Operation sheet gives direction on how to perform a single manipulative task. This would include the directions on how to operate a machine.
>
> Job sheet gives direction on how to do, completely and in a proper sequence, a number of operations. The procedure for making a product or doing an experiment, would constitute a job sheet.
>
> Information sheet contains everything necessary for the understanding of an instructional unit which is largely information in nature.
>
> Assignment sheet directs the study to be done by the student on a lesson topic, and may include questions to determine how well a lesson has been learned. (pp. 7-8)

A common element that can be found between the above definitions for the more common types of instruction sheets, is that these instructional

aids are for students to use in a learning environment. These definitions were included because these instructional materials were used in the research to supplement the instruction provided by the teacher.

STUDENT MANUAL

Manufacturer's manuals are commonly used in the world of commerce and industry because anything that is made by man can either malfunction or breakdown. These manuals are used by service personnel as they test, disassemble, repair, assemble and retest a part or machine that has been repaired.

Silvius and Curry (1953) in Teaching Successfully Industrial Arts and Vocational Subjects state that these manuals as well as operator's manuals are used to explain the mechanism of machines and deal primarily with either the maintenance or operation of a machine. (p. 224)

According to Pucel and Knaak (1975), manufacturer's manuals were usually well illustrated and were produced by highly qualified technical writers employed or contracted by the concern. (p. 111) They also stated that a manual resembled a series of individual instruction sheets bound in sequence. (p. 111)

A similar form of instructional material is used in education and is categorised as a student manual. According to the Junior High Industrial Education Guide (1976) a student manual:

> outlines in detail specific activities and assignments students are to do. This is a "guide" for the student to follow. It includes instruction to read specific pages in a reference book, to view a film strip, to work out given problems and/or to outline the procedure for an activity. (p. 8)

Although in some respects student manuals were similar to the manuals produced and distributed by manufacturers to their service personnel, for the purpose of this study, they were used to supplement the instruction of the teacher.

POPULATION AND SAMPLE

The population for this investigation included two discrete groups of students that were drawn from the same junior high school that was part of the school system of the Calgary Board of Education. These students were selected to be involved in the study because they were readily available to the researcher.

TREATMENT GROUP

The first group of students were classified as the treatment group. The treatment group included students of both sexes from grades 7, 8 and 9 who were enrolled in an elective course in industrial arts and who were also enrolled in mandatory core courses of mathematics and science.

NON-TREATMENT GROUP

The second group of students, the non-treatment group, were not enrolled in the elective program for industrial arts but were enrolled in the mandatory core courses of mathematics and science.

Data in Table 1 show that a total of 581 students made up the two groups of students involved in the research at the start of the 1981-82 school year. Of these 581 students, there were 168 classified as grade 7 students, 214 as grade 8 students and 199 as grade 9 students.

Because the study lasted over the school year 1981-82 and because of the mobility of students in the population of the participating school, some data were missing. Pretest data were missing for 28 students who entered the school after the other students had written the grade specific and subject specific internal department examinations in November 1981. Scores on these first quarter examinations provided the pretest scores for participants. Those scores did not include the 28 students who registered late.

Post-test data were missing for an additional 77 students. Thirty-nine of these students left the school because of transfer and 38 students did not have final marks recorded on the 25A form for the internal department examination or the departmental examination for mathematics and science. Consequently, students with missing data were eliminated from the statistical analysis of the study.

TABLE 1

RESEARCH POPULATION

	INITIAL REGISTRATION			ELIMINATED			FINAL DATA USED IN RESEARCH ANALYSIS	
Grade	Students	Treatment Group	Non-Treatment Group	Transfers	Missing marks	Lates	Treatment Group	Non-Treatment Group
7	168	74	94	10	3	10	67	88
8	214	71	143	19	30	10	53	112
9	199	64	135	10	5	8	56	128
TOTAL	581	209	372	39	38	28	176	328

Data in this table show that the number of students in the non-treatment group were approximately double that of the treatment

group, 328 to 176 respectively.

The population of the participating school came from an area of the City of Calgary which housed people and families which could be classified sociologically as working class. In many cases, both parents or guardians worked in a salaried position or worked at either a skilled or semi-skilled occupation.

In the participating school, there were two homerooms for students who spoke English as a second language which was an indication that a significant number of new Canadians resided in the service area of the school which provided these students with special provisions to meet their needs.

INSTRUMENTATION

The two instruments used to collect data were the internal departmental examinations in mathematics and science of the junior high school that participated in this study and the grade 9 departmental examinations for mathematics and science which were set by the Calgary Board of Education for the school year 1981-82, the year in which this study took place.

INTERNAL DEPARTMENTAL EXAMINATIONS

For approximately ten years, the teachers in the mathematics and science departments worked as a team to design and set examinations in mathematics and science for grades 7, 8 and 9 of the school. These examinations were considered to be internal departmental examinations and were used by grade level teachers in these two subject areas. The examinations were based on the Bloom's taxanomy and were designed

following prescribed criteria supplied to the teachers by the Calgary Board of Education. To establish validity and reliability, these examinations were revised and updated each year. For the purpose of this study, these examinations will be referred to as internal departmental examinations.

DEPARTMENTAL EXAMINATIONS

The grade 9 departmental examinations in mathematics and science that were administered at the end of the school year were designed by personnel of the Program Evaluation and Research Section of the Calgary Board of Education. The grade 9 departmental examinations were based on the sample blue print grid shown in Appendix "C" on page 91 for mathematics and Appendix "D" on page 93 for science. Prior to being used in this research, these examinations were field tested and revised a number of times before they were administered at the end of the 1981-82 school year to the grade 9 students.

PRETEST SCORES

Pretest scores for mathematics and science for students in both the treatment and non-treatment groups were the scores that these students received on their grade level internal departmental examinations. Because these examinations were subject specific, they were marked by subject area teachers and the marks were recorded on 25A forms which were filed in the general office of the school. These examinations were written by these students in November 1981, the end of the first quarter of the 1981-82 school year.

POST-TEST SCORES

The following procedure was used to secure post-test scores for the population of this study.

Post-test scores for grade 7 and 8 students were the final marks that the students received on the mathematics and science internal departmental examinations which were administered in June 1982, the end of the 1981-82 school year. These examinations were marked by subject area teachers who recorded the results on 25A forms.

For grade 9 students post-test scores were the final marks that students received on the mathematics and science departmental examination. This examination, like the internal departmental examination, was administered in June 1982. After the students wrote these examinations, they were returned unmarked to the Central Office where personnel from Program Evaluation scored the examination. The marks that the students received were returned to the school where they were recorded on 25A forms.

RESEARCH DESIGN

A review of the literature on research design was conducted in order to identify the most appropriate experimental design to be used with this study. From this literature review, a decision was made to use the non-equivalent control group design proposed by Campbell and Stanley (1963, p. 47) in Experimental and Quasi-Experimental Design for Research. The research design written in Campbell's notation was:

Experimental Group	O_1 X	O_3
Control Group	O_2	O_4

O_1 and O_2 represented pretest scores of the experimental and control groups respectively. O_3 and O_4 represented post-test scores and X represented the treatment which, in this research, was the industrial arts learning activities. This was Campbell and Stanley's statement about the use of this design in conducting research in education.

> Rather, the groups constitute naturally assembled collectives such as classrooms, as similar as availability permits, but yet not so similar that one can dispense with post-tests. The assignment of x, the treatment, to one group or the other is assumed to be random and under the experimentor's control. (p. 47)

Campbell and Stanley further asserted:

> Assuming that the groups are approximated for purposes of internal validity, this design can be regarded as controlling the main effects of history, maturation, testing and instrumentation. (p. 48)

Best (1970) in Research in Education, would support the use of this research design while Mouly (1970) in The Science of Educational Research, would also concur with the use of this design by stating:

> In education, where experiments frequently have to be based on pre-formed groups, randomizing subjects among the treatment groups is out of the question. (p. 338)

Finally, because of the following advantages, this design was an ideal type for this type of study:

The study was reasonably economical.

It had built-in theoretical controls.

It was statistically simple.

The control group gave it comparability required by science.

HYPOTHESES

The following hypotheses were established for this research:

1. The treatment group would have a higher mean score than the non-treatment group on the grade 7 internal departmental mathematics examinations.
2. The treatment group would have a higher mean score than the non - treatment group on the grade 7 internal departmental examination in science.
3. The treatment group would have a higher mean score than the non-treatment group on the grade 8 internal departmental examination in mathematics.
4. The treatment group would have a higher mean score than the non-treatment group on the grade 8 internal departmental examination in science.
5. The treatment group would have a higher mean score than the non-treatment group on the grade 9 departmental examination in mathematics.
6. The treatment group would have a higher mean score than the non-treatment group on the grade 9 departmental examination in science.

LIMITATIONS

Listed below are the limitations that applied to this investigation.

The study was limited to the one junior high school that was part of the Calgary Board of Education.

In the participating school, the study was limited to those students who were enrolled in industrial arts during the time that the study was conducted.

The study was limited to the 1981-82 school year.

A fourth limitation that was imposed on this study was the amount of time that each student spent in each area of the industrial arts laboratory and the kind of learning activities, in these areas, that helped to reinforce the concepts, theories, laws and principles found in mathematics and science.

METHODOLOGY

The following methodology was used to bring this study to its conclusion.

Prior to the end of the 1980-81 school year, both boys and girls in the participating school were given the opportunity to select the option courses they would take in the next school year. These students were instructed by the school principal to list these courses in order of priority. The principal also advised these students to discuss the options they had selected with their parent or guardian. Following this discussion, the student was to return the option sheet to the school. On the basis of their first or second choice, students were assigned to option courses which they took in September 1981. See Appendix A, page 81, for a listing of the option courses that were available to grades 7, 8 and 9 students during the 1981-82 school year.

All students enrolled in grades 7, 8 and 9 in September 1981, began both their core and option course work. Those students who were enrolled in grades 7, 8 and 9 and who took both the required core subjects Language Arts, Mathematics, Science, Social Studies, Physical Education and in grade 9, group Guidance and an industrial arts option, were the treatment group. Students in these three grades who were

enrolled in core subjects but did not elect an industrial arts option were classified as the non-treatment group.

At the end of the first quarter of the 1981-82 school year, November 1981, students in both the treatment and non-treatment groups wrote grade specific internal department examinations for mathematics and science. These examinations were written by research participants on a day that was set aside for this purpose. The scores that these students received on these examinations were used by the researcher as pretest scores. How these examinations were scored is described in a previous section of this chapter.

During the course of the school year, students in the treatment group were involved in learning activities in industrial arts that would reinforce some of the concepts that were taught by either the mathematics teacher or the science teacher. For example, in some of these activities, the student had to compute linear dimensions which involved the four basic functions of mathematics - addition, subtraction, multiplication, and division.

The following is an example of an industrial arts activity where the student used these functions.

Five pieces of plyboard 1.9 cm x 35 cm x 90 cm were required to make a book shelf. What was the cost of the plyboard if 19 mm thickness was sold at $\$15.45/m^2$.

Mathematics involved - linear measurement, decimal fraction, multiplication, division. Appendix B, page 85, contains a list of industrial arts learning activities and their relationship to mathematics.

The following is an example of a learning activity that was used to reinforce some of the concepts that were taught in science classes. In this, the researcher demonstrated one of many combining processes by using the soldering process to join metals.

Scientific principle involved - heat and state of matter, adhesion, transfer of heat by conduction, oxidation, color relative to the temperature of hot materials. Other examples of learning activities related to science that the treatment group received in their industrial arts classes can be found in Appendix B, page 85.

To establish quarterly grades for students in the research school, near the end of each quarter students were required to write examinations for each of the core subjects. These examinations were designed by the teacher and were subject specific.

Post-test scores were taken from the scores that research participants received on their final examinations which were administered in June 1982. Grades 7 and 8 participants were administered final examinations that were subject specific and were classified as internal departmental examinations. These examinations were scored by the teachers responsible for teaching the specific course. These teachers placed the score received on 25A forms for record keeping.

Post-test scores for grade 9 research participants were those scores that these students received on the mathematics and science final examinations that were administered at the end of the 1981-82 school year. These examinations were designed by personnel of the Program Evaluation and Research Section of the Calgary Board of Education. The completed examination papers for all grade 9 students were returned to

that Section for scoring. These scores were returned to the school where they were placed on 25A forms for record keeping.

To assist the researcher in selecting the correct statistical procedure to be used for analysing the collected data, the Director of the Division of Educational Research Service, Faculty of Education, The University of Alberta was consulted. From that consultation, the decision was made by the researcher to use the Analysis of Variance (ANOVA) package from the Statistical Package for Social Sciences (SPSS) which is a library of programs used to analyse data. There were two basic reasons for selecting the ANOVA. Firstly, the ANOVA was the most common statistical procedure used in educational research, and secondly the program was available. Cook and Campbell (1979) would support the use of ANOVA for analysis of data from non-equivalent groups when they wrote:

> We stress these designs for the following reasons. First non-equivalent group designs without controlled selection are far more common in practice than non-equivalent group designs with controlled selection. (p. 147)

In order to process the data for analyses, the researcher received the following assistance from the Division of Educational Research Services. A member of the clerical staff from the Division was assigned the task to keypunch both pretest and post-test scores on to 80 column IBM cards. A graduate student was assigned to assist the researcher with the operation of the computer and the analysis of data.

Both pretest and post-test scores were secured from the 25A forms by the researcher who requested these forms from the principal of the participating school. Prior permission to use these forms was granted in a letter from the Calgary Board of Education. This letter was

countersigned by J. Van Der Lee, Supervisor (Research and Testing) Program Evaluation and E.H. Elkins, Acting Deputy Superintendent, of the Division of Instructional Services.

The researcher delivered these scores to personnel of the Division of Educational Research Services, where they were keypunched and electronically processed.

The pretest scores of each subject and the respective grades were blocked into three groups; namely, low, medium and high. This was done by using the computer to generate a frequency list of the pretest scores for each subject and respective grade and then these scores were manually checked and divided into approximately three equal groups.

The analysis of variance (ANOVA) was computed on the post-test scores for both subjects, mathematics and science, to determine if there was a significant difference between the treatment and the non-treatment groups on these test scores.

The 0.05 level of significance for the two-tailed test was used to decide if there was a significant difference between the groups which were being compared in this study. In conforming with convention, the 0.05 level of significance was used. Young and Veldman (1965) wrote:

> statisticians have generally agreed to reject the null hypothesis when the chances are equal to or less than 5 percent that the observed series of events is due to chance. (p. 10)

In this statement, Cook and Campbell (1979) recommend the use of blocking:

> There are some undeniable advantages of using the block design instead of either the elementary ANOVA or the ANCOVA. Compared to the elementary ANOVA, the block design permits the additional test of whether the treatment blocks interact. (p. 178)

The support of grouping was reinforced by Cochran and Cos (1966) in this quotation:

> Grouping is helpful in coping with the effects of time trends in experiments that extend over a number of work periods. (p. 42)

The blocks, in this study, were done on the pretest scores in mathematics and science for each of the grades involved.

The ANOVA model was used on the post-test scores. Prior to the use of this model, the T-test analysis was done on the pretest scores. Support for the use of this model was shown by Cook and Campbell (1979) in this statement:

> If the result is not statistically significant, the groups are assumed to be equivalent. A result of "no difference" is then used to justify the second step where the ANOVA model is applied to the post-test scores. (p. 152)

ORGANIZATION OF THE REPORT

The remaining chapters of this thesis will have the following organization.

The second chapter presents a review of related research and literature.

The third chapter includes the data analysis of the investigation and the findings which were determined or derived.

The fourth and final chapter summarizes the study, the findings, conclusions, observations resulting from the research and also the suggested recommendtions for further research.

CHAPTER II

REVIEW OF RELATED LITERATURE AND RESEARCH

INTRODUCTION

Chapter I of this thesis gave an extensive and detailed outline of the research and methodology used to bring this study to its conclusion. Included in that chapter was the problem statement, the supporting objectives of the study, the rationale, operational definitions which were applicable to this research, a description of the research population and the treatment and the non-treatment groups. That chapter also incorporated a description of the research instruments, the hypotheses, the limitations applied to the investigation and the procedures which were used to collect data and to analyse such data.

This chapter will be divided into the following components: Ad Hoc Committee on Industrial Arts, categories of subjects, industrial arts program, the mathematics program, the science program, related research and related literature.

AD HOC COMMITTEE ON INDUSTRIAL ARTS

The Curriculum Branch of Alberta Education has the legislative mandate for the preparation of curriculum guides for each program of study that comprise both elementary and secondary education. The direction for the policies of this Branch can be found in Sections 12 and 13 of the Revised School Act (1980). In the past three decades, the curriculum guide for industrial arts and more recently Industrial Education General, has been revised in 1954, 1963, 1969, 1976 and 1982.

To revise these curriculum guides the Curriculum Branch uses a committee structure that is appointed on an Ad Hoc basis. The "Junior High School Ad Hoc Committee on Industrial Arts" functions under the direction of the Secondary School Industrial Arts Curriculum Committee which in turn reports to the Secondary School Curriculum Board.

SELECTION OF MEMBERS

The following procedure is used by the Curriculum Branch to select members to serve on the "Junior High School Ad Hoc Committee on Industrial Arts."

Personnel of Alberta Education, through communication with the Alberta Teachers' Association, request that the Association through its Industrial Education Specialist Council submit a list of names of industrial arts teachers from that Specialist Council to serve on the Curriculum Committee. The Association through its professional publications advertises for industrial arts teachers who were willing to serve on the Committee. From the names received, the Association compiles a list of names and delivers it to the Associate Director of Curriculum for Industrial Education, Alberta Education. From that list, personnel of Alberta Education selected members of the Committee that represent a cross-section of in-service industrial arts teachers. Other members who make up this committee include: the industrial arts consultants from both the Calgary and Edmonton public and separate school boards; a member from the Department of Industrial and Vocational Education of The University of Alberta; and consultants in industrial education from Alberta Education.

THE CURRICULUM GUIDE

It is the responsibility of the Committee to make revisions or modifications to the curriculum guide so that its content is the most recent available and that it is current with existing educational practice. The curriculum guide is considered by the Curriculum Branch to be a service publication. This guide not only contains the content to be taught; but also contains generalizations and sub-concepts a student should acquire by becoming actively involved in a learning activity in industrial arts. It also suggests to the teacher the print and non-print instructional material that can be used to support instruction. The Junior High Industrial Education Guide (1976) in order to provide a breadth of exploratory experiences for the junior high school student, divides the program into four fields of study which were further sub-divided into sixteen modules. The four fields of study are: Power Technology, Materials Technology, Visual Communications and Synthesizing. Power Technology as a field of study for instance includes the modules of Power Mechanics, Electricity, Electronics/ Computer.

The Junior High Industrial Education Guide (1976) states that a field of study is the general title given to the basic technologies represented, e.g. Materials, Visual Communications. (p. 3) This guide continues by elaborating that a module consists of from 15 to 25 hours of work in a field of study. There may be several modules to complete a field of study, e.g. Woods, Metals, Plastics, Leathers in Materials Technology. (p. 3) These modules were not dependent upon any sequential development; any module or a series of modules could be used as an introductory module.

Materials Technology as a field of study included the modules of Wood, Metals, Plastics, Leather and Earths. Visual Communication as a field of study included the modules of Graphics, Drafting and Photography. Synthesizing as a field of study included the modules of Industrial Simulation, Student Contracting and Developmental Research.

The 1976 issue of the Guide recommends that "during the junior high school years . . . ., a student studies a minimum of three different modules each year" (p. 5). The content of modules was designed to be taught from 9 to 12 weeks, depending on the number of areas in operation. Over the school year, there will be several weeks of instructional time for which there seems to be no account. Normally, teachers used this time to prepare, organize and teach some of the beginning lessons.

If a student elected industrial arts as an option course in grades 7, 8 and 9, it would be possible for the student to complete 9 of the 16 modules.

CATEGORIES OF SUBJECTS

There are three categories of subjects that a Juninor High School student can follow. These are core or compulsory subjects, Group A options and Group B options. The core subjects include Language Arts, Social Studies, Mathematics, Science and Physical Education which includes Health Education. In grade 9, Guidance is a compulsory subject and may be offered at the grade 8 and 9 level at the discretion of the local school authorities. (Junior-Senior High School Handbook, 1981-82, pp. 8-9)

The structure of the junior high school program is such that the

following minimum time is accorded for core subjects:

Language Arts	150 hours
Mathematics	100 hours
Science	100 hours
Social Studies	100 hours
Physical Education and Health	75 hours
Group Guidance (grade 9)	25 hours

(The Handbook, p. 9)

Options in the Group A category are exploratory in nature and included the Cultural and Practical Arts - Home Making, Industrial Education, Typewriting. The time accord for Group A options is 75 hours per year or 225 hours over the three years or grades 7, 8 and 9. For Industrial Education courses, curriculum guides are provided by Alberta Education.

Group B options are general electives and are for enrichment of the student. A minimum of 50 hours is the accorded time for each of these options. Curriculum guides are not provided by Alberta Education for Group B options.

INDUSTRIAL ARTS PROGRAM

The industrial arts program in the research school was categorized as an A option and followed the program in the Junior High Industrial Education Guide (1976). The program included the three fields of study: Power Technology, Material Technology, Visual Communications. Instructional content and learning activities from the Synthesizing field of study were integrated with the other three fields of study as they were being taught.

The industrial arts program was taught in a multiple activity laboratory which was a laboratory organized so that three or more

learning activities were in progress simultaneously. To illustrate, this laboratory was organized into a number of different sections or areas, each representing a field of study. Each area was self contained as much as possible with machine and hand tools that were used to perform the learning activities of a given technology. Provision was made in each area for the storage of tools, products and stock required by the learner or the teacher. Each area was large enough to accommodate between four to six students.

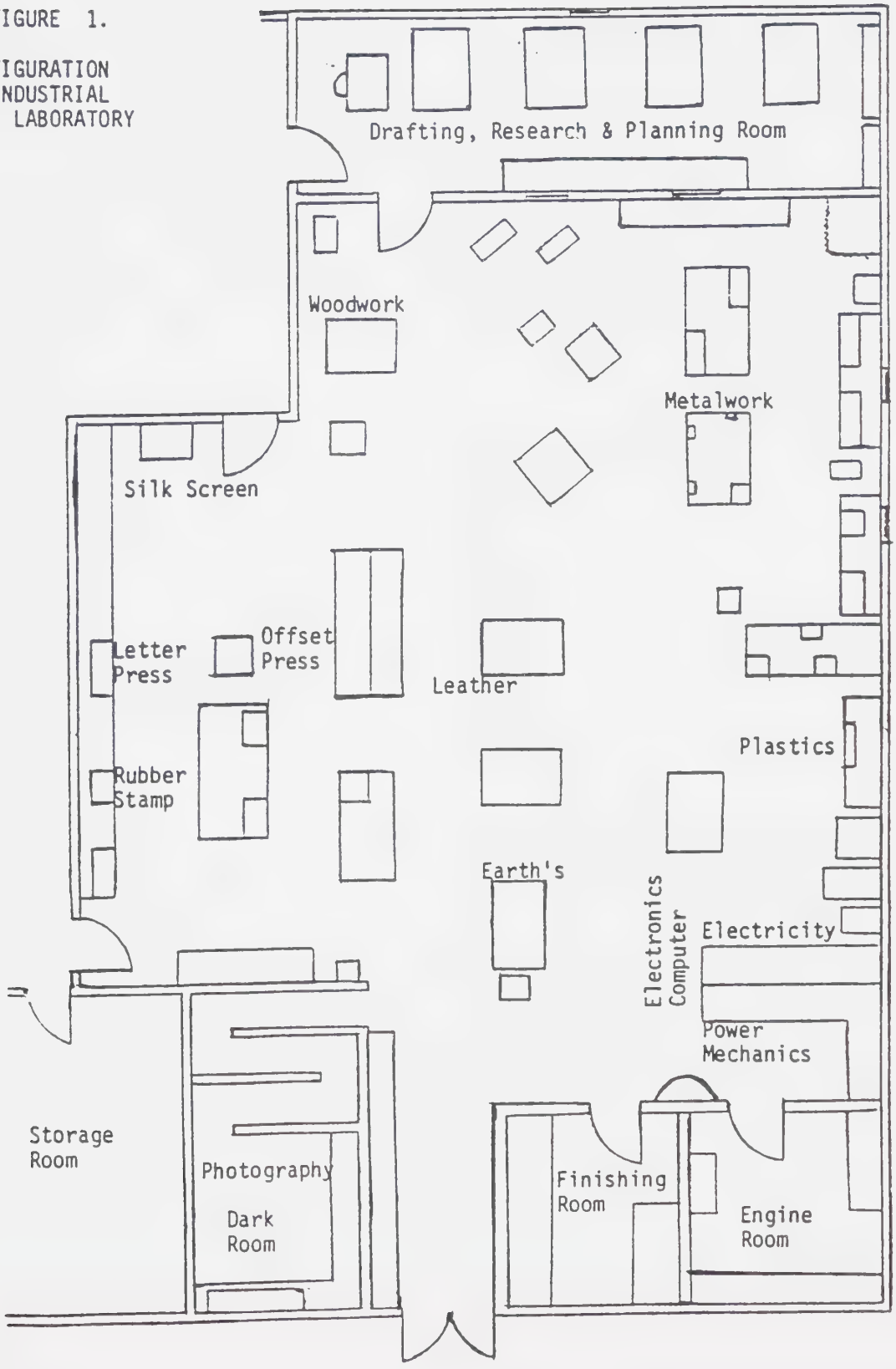
All classes were divided into three or more groups with each group working through an assigned unit of a module in an area. A module represented between 15 to 25 hours of study. Normally, the unit of a module took the student from three to four weeks to complete. After the unit was completed, the group rotated to another area and to a new technology and new learning experiences. During the three years of junior high school, it was possible for the student to complete nine of the sixteen modules of the four technologies. Figure 1 shows the configuration of the industrial arts laboratory where the study was conducted. During the time of the research, students worked in the different areas on predesigned or student designed products. A predesigned product is one that was designed by the teacher because students in grades 7 and 8 did not have the background or knowledge of tools and materials to design their own products.

TIME TABLING

Industrial arts classes were time-tabled on alternate days for one 48 minute period per day. The time-table of the students was tumbled so that students did not have industrial arts at the same time each day

FIGURE 1.

CONFIGURATION OF INDUSTRIAL ARTS LABORATORY



they were in the laboratory. Following this schedule, each industrial arts class received approximately 80 hours of instruction during the school year.

LEARNING ACTIVITIES FOR GRADE 7

The learning activities for grade 7 students were taken from the following fields of study: Power Technology, Materials Technology and Visual Communications. From these fields of study, the following modules were used to organize learning activities for these students.

POWER TECHNOLOGY	Power Mechanics Electricity/Electronics
MATERIALS TECHNOLOGY	Wood Metals Plastics Leather Earths
VISUAL COMMUNICATIONS	Graphics Drafting Photography

The predesigned product was used as a vehicle for teaching skills in the three learning domains that were related to the modules from the three fields of study previously mentioned. The students were required to conduct a series of experiments for the modules from the Power Technology field of study. From these learning activities, students developed awareness level of skills.

LEARNING ACTIVITIES FOR GRADE 8

The students enrolled in the grade 8 industrial arts program of study were involved in learning activities that would reinforce both the activities and the awareness level of skills which they acquired in

grade 7. In addition to reinforcing these activities and skills, these students learned to operate, control or adjust a tool or machine with which they were unfamiliar. To illustrate: the researcher demonstrated how to safely operate the router. After the demonstration, each student was allowed to operate the router. Proper control and safe procedures were emphasized in this and in subsequent demonstrations for the hand tools or the machine tools that the student was to learn.

LEARNING ACTIVITIES FOR GRADE 9

Students in grade 9 in most instances had completed two years of industrial arts. Because of their background, they were permitted to select only two of the more advanced modules from Power Technology, Material Technology or Visual Communication fields of study. These students were required to design and draft a product that was more difficult and which was more advanced than any project they previously made. The products which were designed had to show the inter-relationship of the various technologies found in a productive society.

It was observed that in most cases, the grade 9 students selected a Materials Technology project for their major final assignment. It should be mentioned that at the beginning of the school year, the grade 9 students did a research project in alternate energy sources. This involved a written paper and the design and the building of a system that could be used to harness the energy.

INSTRUCTIONAL MATERIAL

A variety of instructional methods was used to deliver the instructional content for the industrial arts program and to involve and

direct the students in their learning activities. The role of the researcher (teacher) varied according to the instructional method which was being used. In addition, the instructional method usually influenced the type of instructional material which was used to deliver the instructional content of the industrial arts program. This point of view is explored under the sub-headings of "Group" and "Personalized Instruction".

GROUP INSTRUCTION

This teaching format was used to present introductory lessons to grade 7 students. It involved demonstrations which were given on the safe and correct procedures to be followed when using hand tools or machine tools. These demonstrations were often supplemented by such non-print instructional materials as 16 mm films, video-tapes, transparencies and cassette tape recordings.

PERSONALIZED INSTRUCTION

The learning environment of the multiple activity organizational pattern for an industrial arts laboratory is most adaptable to personalizing instruction for the student because of the variety of learning activities that take place concurrently in the areas of the laboratory. To illustrate, students in the Materials Technology Area in constructing a product of wood, metal, or plastics, made use of the A.I.D. booklets or instruction sheets to supplement the instructions of the teacher. In the Power Mechanics Area, students were involved with learning activities which demonstrated how different types of energy were produced, controlled, transmitted, or used. Students in this Area

used A.I.D. booklets, student manuals and instruction sheets to supplement the instruction of the teacher. The role of the teacher was that of a resource person and a manager of the learning environment.

Each industrial arts learning activity that the students were involved with was analysed to identify the mathematical or scientific concepts in each of these activities. The concepts that were identified using this procedure were cross-referenced with the concepts that were identified in the mathematics and science textbooks for each grade level. Chart I shows the relationship between these concepts and the industrial arts activities.

CHART I

RELATIONSHIP BETWEEN INDUSTRIAL ARTS LEARNING ACTIVITIES AND CONCEPTS IN MATHEMATICS AND SCIENCE

INDUSTRIAL ARTS ACTIVITIES	MATHEMATICAL CONCEPTS	SCIENTIFIC CONCEPTS
Woodwork		
Layout	Addition, subtraction division whole numbers and fractions	
Cost of material	Multiplication, addition subtraction, division whole numbers and fractions	
i) Separating Tools e.g. chisel, drill		Principle of wedges. Inclined plane.
ii) Combining, eg. nails, screws		Friction. Inclined plane
Glue. Contact cement		Chemical reaction. Adhesion.

CHART 1 (contd.)

RELATIONSHIP BETWEEN INDUSTRIAL ARTS

iii) Forming - clamps and vises used to apply pressure		Screw as a simple machine. Levers.
Molding		Cell structure of wood.
iv) Finishing, eg. paint		Oxidation. Chemical reaction.
Metal Work		
i) Separating Tools eg. shears, snip		Principle of wedges. Inclined plane. Levers.
ii) Combining- soldering, welding		State of matter. Conduction, convection.
Bolt and nuts		Inclined plane.
iii) Finishing-enamel heat treatment		Oxidation.
Plastics		
Vacuum former	Read pressure gauges	State of matter.
Thermoplastics Thermosetting Plastics		State of matter. Temperature.
Visual Communications		
Drafting	Addition, subtraction division	
Photography	Proportion	Chemical change. Refraction of rays of light.
Offset printing	Measuring	Oil & water does not mix.
Offset plate making	Reading gauges	Chemical reaction light sensitive materials.
Letter press		Levers.
Rubber stamp process	Measuring	State of matter.

CHART 1 (contd.)

RELATIONSHIP BETWEEN INDUSTRIAL ARTS

Power Technology

Gasoline 4-stroke engine	Volume calculation Addition, subtraction, division, multiplication	Fossil fuel. Energy changes.
Mechanical controls	Addition, subraction, division, multiplication	Pulleys, levers, gears.
Electrical controls	Addition, division, subtraction, multiplication	Sources of electricity, mechanical. Chemical. Solar. Thermocouple.
Fluid controls	Addition, subtraction	State of matter.

THE TWO CORE SUBJECTS

MATHEMATICS: Grades 7, 8, and 9

One of the core courses that is compulsory for all junior high school students in Alberta is mathematics. The minimum time allotted to this course at any junior high school grade is 100 hours per year per course, or a total minimum of 300 hours over the three years of junior high school. To assist teachers of mathematics to organize their instructional content, the Curriculum Branch of Alberta Education published the Junior High School Mathematics Curriculum Guide.

Students in grades 7, 8 and 9 who made up the research population of the research school were scheduled on a daily basis to have 48 minutes of mathematics during each day of the school year which was 190 days in length.

Remedial work in mathematics was available for the exceptional students who were experiencing difficulty and for those who were having success in this subject area. Grade 9 students who were high achievers in mathematics were given the privilege to do orientation work with a

mini computer by programming an Apple II. One period per week was set aside to teach reading which was related to the mathematics program.

Instructional content for the mathematics program of the school was taken from the following text books: Grade 7 Math is/1, by Ebos, Robinson and Pogue (1975); Grade 8, Math is/2 by Ebos and Robinson (1975); Grade 9, Math is/3 by Ebos and Tuck (1976).

MATHEMATICAL CONCEPTS

The mathematics textbooks for grades 7, 8 and 9 used in the research school were analysed to identify the mathematical concepts that were part of the content of each text book. To assist in making this analysis, a chart patterned after Verret (1977) was used. The results of the procedure is shown in Chart II.

CHART II

MATHEMATICAL KNOWLEDGE AND SKILLS IDENTIFIED IN MATHEMATICS TEXTBOOKS FOR GRADES 7, 8 AND 9

MATHEMATICAL KNOWLEDGE AND SKILL ITEM	MATH 1 GRADE 7	MATH 2 GRADE 8	MATH 3 GRADE 9
Addition with whole numbers	x	x	x
Subtraction with whole numbers	x	x	x
Multiplication - whole numbers	x	x	x
Division - whole numbers	x	x	x
Fractions - additions, subtraction, multiplication, division	x	x	x
Conversion of common fraction to decimal	x	x	x
Percent - used to calculate tolerance	x	x	x
Knowing and using common metric weights and measures	x	x	x

CHART II (contd.)

MATHEMATICAL KNOWLEDGE AND SKILLS

MATHEMATICAL KNOWLEDGE AND SKILL ITEM	MATH 1 GRADE 7	MATH 2 GRADE 8	MATH 3 GRADE 9
Knowing and using common English weights and measures			
Converting English to metric weights and measures			
Measuring with rule or tape	x	x	x
Measuring with micrometer or with calipers			
Estimation of measurements			
Reading gauges and meters			
Calculating ratio and proportion	x	x	x
Solving ratio and proportion problems	x	x	x
Interpreting line and/or bar graphs	x	x	x
Applying formula or equation	x	x	x
Knowing the meaning of parallelism between lines and/or plane	x	x	x
Knowing basic geometric figures, eg. square, rectangle, hexagon, cylinder	x	x	x
Measuring angles	x	x	x
Laying out or adjusting angles to a given number of degrees	x	x	x
Calculating area of common geometric figures, eg. square, rectangle, circle	x	x	x
Calculating perimeter of common geometric figures	x	x	x
Calculation of volume of common geometric solids, eg. cylindrical prism, rectangular prism	x	x	x
Using calculator for basic operations			
Record keeping			
Basic Computer Programming			

SCIENCE: Grades 7, 8, and 9

Another core course that is compulsory for all junior high school students in Alberta is Science. The minimum time allotted to this course at any junior high grade is 100 hours per year per course or a total minimum of 300 hours over the three years of junior high school. To assist teachers of Science to organize their instructional content, the Curriculum Branch of Alberta Education publishes the Curriculum Guide for Junior High School Science.

Students in grades 7, 8 and 9 who made up the research population of the research school were scheduled on a daily basis to have 48 minutes of Science during each day of the school year. Remedial work in Science was available for students who were experiencing difficulty with the regular Science program in the class room. These students were placed in a class which had a pupil/teacher ratio of approximately 10 students to one Science teacher. Students who had extreme difficulty with Science were sent to a resource room where the teacher was able to provide more individual attention to the Science instruction of the student. When students demonstrated a reasonable amount of progress, they were returned to the main stream of the Science classes.

Content for the Science program of the school was taken from the following texts: Grade 7 Life Science by Carter, Goodman, Hunter and Schelske (1971) and also Life Science authored by Smallwood (1976); Grade 8 Earth Science by Jackson and Evans (1976) and Earth Science authored by Heller, Byrene, Darby, Dexter, Hawkins, Kaufmanis and Ojakangas (1976); Grade 9, Physical Science by Andrews, Wolfe and Eix (1978) and Physical Science by Macnaughton and Heath (1976).

SCIENTIFIC CONCEPTS

These science textbooks were reviewed and analysed to ascertain the scientific concepts and skills which were relevant to the industrial arts learning activities. These scientific knowledge and skills are included in Chart III.

CHART III

SCIENTIFIC KNOWLEDGE AND SKILLS IDENTIFIED IN SCIENCE TEXTBOOKS FOR GRADES 7, 8 AND 9

SCIENTIFIC KNOWLEDGE AND SKILL ITEMS	TEXTBOOKS		
	GRADE 7	GRADE 8	GRADE 9
Plant cells (trees and wood)	x		
Oxygen supports life and also combustion, eg. oxidation	x	x	x
Oxides		x	x
Pollution - air, land, water	x		
By-products of combustion, eg. carbon dioxide, carbon monoxide	x	x	x
Atoms	x	x	x
Minerals		x	x
Fossil fuels		x	x
Physical change		x	x
Chemical change		x	x
Compound	x		x
Cohesion			x
Adhesion			x
Compounds		x	x
Elements		x	x
Friction		x	x
Force		x	x
Inclined plane. Wedge.			x
Levers. Pulleys			x
Screw as a simple machine			x

CHART III (contd.)

SCIENTIFIC KNOWLEDGE AND SKILLS

SCIENTIFIC KNOWLEDGE AND SKILL ITEMS	TEXTBOOKS		
	GRADE 7	GRADE 8	GRADE 9
State of matter		x	x
Conduction, convection, radiation		x	x
Light - refraction, reflection, spectrum		x	x
Light - ultraviolet rays	x	x	x
Energy - production			x
Evaporation, condensation		x	x
Capillary attraction	x		x
Classification	x	x	x
Metric system of measurement	x	x	x
Energy - alternative sources		x	x

RELATED RESEARCH

The researcher conducted an information retrieval search of the Educational Resources Information Centre (ERIC) data base, as well as a manual search of the standard indices for reporting the findings of educational research. The descriptors that were used to search the ERIC data base were: industrial arts, high school students and objectives. The search on the ERIC data base located one article by Calder (1977) which was published in Man/Society/Technology, December 1977. The title of that article was "Industrial Arts and Its Implication For Learning In Other Subjects". The content of this article is tangentially related to the current study because Calder indicated how industrial arts techniques and learning activities can be used to reinforce skills in such subject areas as mathematics, science and language development.

From the manual search of the standard indices for reporting the findings of educational research, it was found that a number of master's theses and doctoral dissertations relating to this study, had been completed at unversities in the United States and in Canada. The manual search of Master's Theses in Education, edited by Silvey, was conducted using the headings of Industrial Arts, Mathematics and Science as descriptors. This search included reviewing all of the volumes from 1960 to 1980 inclusive. The following is a list of the Master's Theses which were considered relevant to this study.

YEAR OF COMPLETION	AUTHOR	TITLE
1977-78	G.C. Verret	Identifying Mathematical Competences for Three Selected Trades
1976-77	R. Maslow	Effect of Manipulative Activities on the Attitudes and Achievement of Algebra Students in an Inner-City High School
1976-77	James V. Cali	A Study of Coinciding Classes of Industrial Arts - Mathematics
1973-74	Steven Bushrod	Role of Industrial Arts in Secondary Schools
1970-71	Yuan H. Lui	The Effects of Industrial Arts Mathematics Achievement
1971-72	Harold D. Bryan	The Objectives of Industrial Arts - a Study of the Relationship of Theory to Application

YEAR OF COMPLETION	AUTHOR	TITLE
1970-71	Karen J. Schilling	Industrial Arts Activities Recommended for Unit Integration in Science in the Primary Elementary Grades, Kindergarten through Grade 3
1969-70	Harold Parker	Mathematical Operations Fundamental to Mechanical Drafting
1969-70	Merlin R. Self	Industrial Arts Activities Recommended for Integration in Mathematics Programs for Grades 4, 5 and 6
1967-68	Ronald E. Lough	The Effect of an Industrial Project in Reinforcing Classroom Instruction on Selected Measurement Concepts
1965-64	Edward L. Remich	A Study of an Experimental Program of Integrated Industrial Arts Science in Junior High
1967-68	Donald W. Manuel	The Effect of Industrial Arts on Science Achievement
1960-61	J.D. Fox	A Study of the Application of Science and Mathematics in Industrial Arts
1959-60	L.P. La Plant	An Investigation of Some Possibilities for Increasing Mathematics Understanding Through Industrial Arts

The manual search of dissertation abstracts indicated that research investigations completed by Arlen (1980), Pershern (1967), Peel (1967), Noll (1967) and Bowman (1958) were accomplished to meet the requirements for the doctoral degree.

A summary or extract of investigations, which dealt with the relationship of industrial arts learning activities to mathematics and science concepts, will now be presented in chronological order.

ARLEN (1980)

Arlen's study was to determine whether a relationship existed between student attitude, reading and mathematics scores and the overall performance level of students in a junior high school industrial arts program. Positive significant relationships were found for all major and minor hypotheses investigated. The study indicated a significant positive relationship (beyond the 0.001 level) existed between students' mathematic scores and students' overall performance level in industrial arts. The results of Arlen's study is relevant to this study because they demonstrated that mathematics concepts were used or applied during student learning activities in the industrial arts laboratory.

VERRET (1977)

The purpose of Verret's thesis was to identify the mathematical skills, knowledge and understandings that a certified journeyman performing the functions of either supervisor or practicing tradesman or instructor, considered necessary to be able to successfully practice their trade. The population of the study was certified journeymen in the motor mechanic trade, heavy duty mechanic trade and the welder

trade. The conclusion of this investigation was that a number of basic mathematical knowledges and skills were necessary for a journeyman to successfully practice in the trades which were being studied. The results of Verret's investigation is related to current research because some of the mathematical concepts that were identified are used with the learning activities found in an industrial arts laboratory. Some of the mathematical knowledge and skills selected from Verret's thesis are shown in Chart II on pages 44-45 of this report.

LIU (1970)

The purpose of the research conducted by Liu was to examine an industrial arts objective which stated that industrial arts was to provide an environment where students can reinforce and apply the academic disciplines. The study attempted to find the effect that taking industrial arts had on a learner's achievement in grade 9 mathematics. This research was conducted during the 1969-1970 school year. The research population was only girls from four junior high schools in the Edmonton Separate School System. These girls in the treatment group had no prior industrial arts education. Boys were not involved in the research because it was thought that they would have had some industrial arts education during their years as junior high school students. Consequently, boys were not a part of the treatment group. The results of this research indicate that there was no significant difference between the treatment and the non-treatment groups on their achievement in mathematics test that was set by the Department of Education in 1970. This study was similar in some respects to the current research because Liu endeavoured to find statistical support for

the fact that industrial arts learning activities would reinforce mathematical concepts which were taught to grade 9 students.

PERSHERN (1967)

Pershern tried to determine the effectiveness of integrating industrial arts activities with the teaching of Science in 4th, 5th and 6th grades. Special attention was paid to student achievement in the area of Science which dealt with electricity and machines. The population was students from grades 4, 5 and 6 of Burris Laboratory School, Ball State University, Muncie, Indiana. From the data and the limitations that were imposed on this study, the researcher concluded that all groups showed gains in achievement as a result of being part of the industrial arts instructional program. Pershern's study was similar to the current study because it attempted to determine if industrial arts activities could be used to reinforce scientific concepts. (pp. 68-69)

PEEL (1967)

The purpose of the study conducted by Peel was to identify the mathematics that were required by industrial workers who were performing jobs that did not require either a high school education or diploma. The population for this research was taken from two industrial manufacturing plants and included workers who were: assemblers, machine workers, material handlers or inspectors. All these workers received their training on the job. On the basis of the research findings, the following conclusion was made: Employees perceived that in their job they used the four fundamental mathematical operations: addition,

subtraction, multiplication and division and a combination of the basic operations were frequenty used. The results of Peel's study tend to support some of the findings of the current study because that study showed that basic mathematics concepts were applied in some manufacturing industries just as they were applied in industrial arts learning activities.

MANUEL (1965)

The purpose of Manuel's study was to determine what effect, if any, an experimental industrial arts curriculum had upon a learner's achievement in grade 9 science. The population of this investigation was all grade 9 girls from a junior high school in the Edmonton Public School System. The statistical results did not indicate that the experimental industrial arts curriculum affected the learner's achievement in grade 9 Science. Manuel's study in some respects was similar to the current study because it tried to determine if learning activities in an experimental industrial arts curriculum did reinforce science concepts.

FOX (1961)

Fox in a study of the application of science and mathematics in industrial arts wrote:

> Application of mathematics in industrial arts may be taught at any grade level from elementary through to high school. (p. 53)

This study is similar to the current study because the results indicated that mathematical concepts are applied during industrial arts learning activities.

LA PLANT (1959)

La Plant in a study of investigation of some possibilities for increasing mathematical understanding through industrial arts wrote:

> The correlation of mathematics and industrial arts will probably increase the student's proficiency in industrial arts activities as well as contribute materially to his understanding of basic mathematical concepts.
>
> Through a variety of examples, it has been shown that in almost all areas of industrial arts, there are opportunities for improving mathematics understanding. While certain industrial arts activities such as woodworking, graphic arts, handicrafts and basic metalworking lend themselves to the development of the more elementary mathematical concepts and operations, opportunities for more advance topics do exist. (pp. 64-65)

The basic thrust of the current study was similar in some respects to the research conducted by La Plant because he indicated that industrial arts learning activities could contribute to the increased understanding of some mathematical concepts.

RELATED LITERATURE

Many writers and educators like Feirer and Lindbeck (1964), Ziel (1966) and Maley (1982) have expounded on the contribution that industrial arts activities can make to general education and the development of the whole student. A synthesis of the basic ideas generated by these writers is that industrial arts activities offer a multisensory approach to the learning activity being taught and industrial arts activities are able to add an interdisciplinary dimension to the educative process. The theme selected by the American Industrial Arts Association for its 1982 convention was "The Contribution of Industrial Arts to Selected Areas of Education".

In the 31st yearbook, of the American Council on Industrial Arts Teacher Education, Maley contributed a chapter "Industrial Arts Puts the Whole Student in the School." In that chapter, Maley presented what he considered to be ten conceptual dimensions for activities in industrial arts. Two of these concepts were:

> The industrial arts activity is based on the idea that the learner is involved in an experience that is multisensory. As such, it has the potential for the learner to use the senses of smell, taste, touch, sight and hearing.
>
> The industrial arts activity has a rich potential for a strong intellectual involvement in such functions as creating, analyzing, assimilating and perceiving. (p. 248)

Maley expanded these two concepts as well as the others and illustrated how industrial arts activities could play a significant role in the educational development of the learner.

Another thrust of this study was the concept that industrial arts activities could be used to reinforce academic subjects. Giachiono and Gallington (1961) supported this position by stating:

> Many of the methods of science and the main scientific facts concerning the nature of the world and of man are best illustrated in the materials, processes and technology of modern industry. Industrial Arts seeks to present these methods and facts as they are evolved. (p. 69)

In support of the same concept Feirer and Lindbeck (1964) wrote that industrial arts utilizes and reinforces many mathematical concepts in its extensive use of measuring devices and computational formula. (pp. 29-30)

In a continued drive to emphasize the concept, Feirer and Lindbeck stated:

> Industrial arts provide the student with opportunities to apply in a meaningful manner what he has learned in physics, communications, chemistry and mathematics. (p. 40)

Some concerns about the possible achievement of the concept during the industrial arts learning activities were expressed when Feirer and Lindbeck prefaced their statements by suggesting that the onus for the implementation of the concept rests clearly upon the competence of the industrial arts teacher in depicting the related mathematical and scientific concepts to industrial arts learning activities. The concerns generated by these authors are incorporated in this statement:

> The great problem in making mathematics and science come to life in the industrial arts laboratory is one of the teacher competence in these areas; the teacher must be able to bring out the relationship that exist between science, mathematics, technology and industry. (p. 86)

The California State Department publications entitled Mathematics and Industrial Arts Education (1960) and also Industrial Arts and Science (1965) are practical examples of their approach to the concept that industrial arts learning activities could be used to reinforce mathematical and scientific concepts. In these publications are practical examples which could be used by industrial arts teachers who wish to emphasize mathematical and scientific concepts in the industrial arts laboratory.

SUMMARY

This chapter gave a brief overview of the structure and the functions of the Ad Hoc Committee on Industrial Arts. It showed that this Committee had considerable influence on the curriculum guides which

were developed and improved to keep abreast of the current trends in industry.

Secondly, the categories of subjects taught in the Junior High School, were reviewed and the allocation of the time given to core subjects and options was mentioned.

Thirdly, there was a detailed review of the industrial arts program, the mathematics program and the science program. These were the courses which were directly related to this study.

Fourthly, there was a review of research which were similar or related to this study. The purpose, population and conclusion of the related research were indicated.

Finally, literature related to this study were indicated and a brief outline was given to show how they supported this investigation.

CHAPTER III

ANALYSIS OF DATA

The previous chapter contained a review of the literature and research that were either directly or tangentially related to this study. This chapter presents the analysis and results of the data which were collected during the research.

It will be recalled from Chapter I that the instruments used to collect the data were the internal departmental examinations in mathematics and science of the junior high school that participated in this study and the grade 9 departmental examinations for mathematics and science which were set by the Calgary Board of Education. It will also be recalled that after due consultation with the Director of the Division of Educational Research Services, the researcher selected the Analysis of Variance (ANOVA) package from the Statistical Package for Social Science (SPSS), to analyse the pretest data and post-test data that were collected.

RESEARCH POPULATION

The research design for this study involved a population of students from the research school who were enrolled in grades 7, 8 and 9. This population was divided into two discrete groups - the treatment group and the non-treatment group. The treatment group comprised students who requested industrial arts as a first or second option. The non-treatment group consisted of students who were not allowed to do industrial arts as an option during the school year or who did not

select industrial arts as an option. Students in the treatment group were enrolled in a group A elective course in industrial arts as well as being enrolled in mathematics and Science.

Students in the non-treatment group were not enrolled in the industrial arts course but were enrolled in the two mandatory core courses of mathematics and Science.

PRETEST SCORES

At the end of the first quarter of the 1981-82 school year, students in the research population wrote a grade specific internal department examination for mathematics and science. These scores were rounded off to multiples of five and recorded on 25A forms which were on file in the general office of the research school. These scores were used as the pretest scores for this investigation.

PRETEST DATA ANALYSIS

To generate a frequency list of the pretest score, these scores were placed on 80 column IBM cards and placed in the computer. The frequency list that was generated was checked manually and then blocked into three approximately equal groups that were classified low, medium and high. When the attempt was made to get equal numbers of students in each of the low, medium and high groups, it was observed that two groups would have scores which were similar. On the advice of the graduate student who was delegated to assist the researcher, the cut off points were adjusted so that each group would have its own range of score. Consequently, this resulted in variations in the numbers in each group, variations in the range of scores and also variations in the intervals.

Because the scores were rounded off to multiples of five, the classification into groups gave the impression that some score numbers were missing. The results of the blocking process and the group means are listed in Tables 2, 3 and 4 for grades 7, 8 and 9 respectively. A T-test analysis was done on the pretest scores. The results from that process are summarized in Tables 5, 6 and 7 for grades 7, 8 and 9 respectively. Each table for each grade, has the mathematics and science results.

TABLE 2

RESULTS OF BLOCKING PRETEST SCORES
FOR GRADE 7 PARTICIPANTS

		B L O C K S		
SUBJECTS	RANGE OF SCORES	Low 25-65	Medium 70-75	High 80-100
MATHEMATICS	Treatment Group Mean	51.88 (N=24)	69.44 (N=27)	80.63 (N=16)
	Non-Treatment Group Mean	58.45 (N=29)	70.67 (N=30)	83.28 (N=29)
	Range of Scores	Low 35-65	Medium 70-75	High 80-100
SCIENCE	Treatment Group Mean	56.18 (N=38)	70.00 (N=13)	81.25 (N=16)
	Non-Treatment Group Mean	54.26 (N=27)	68.38 (N=34)	77.04 (N=27)

The blocking was done in order to cope with the effects of time on research which in this study extended over a number of quarters in the school year.

TABLE 3

RESULTS OF BLOCKING PRETEST SCORES
FOR GRADE 8 PARTICIPANTS

		BLOCKS		
		Low	Medium	High
SUBJECTS	RANGE OF SCORES	30-60	65-75	80-100
MATHEMATICS	Treatment Group Mean	45.88 (N=17)	61.60 (N=25)	74.55 (N=11)
	Non-Treatment Group Mean	47.92 (N=36)	56.28 (N=39)	76.08 (N=37)
		Low	Medium	High
	RANGE OF SCORES	35-55	60-70	75-100
SCIENCE	Treatment Group Mean	51.32 (N=19)	65.68 (N=22)	79.58 (N=12)
	Non-Treatment Group Mean	50.81 (N=43)	64.52 (N=31)	77.76 (N=38)

TABLE 4

RESULTS OF BLOCKING PRETEST SCORES
FOR GRADE 9 PARTICIPANTS

		BLOCKS		
		Low	Medium	High
SUBJECTS	RANGE OF SCORES	36-60	65-75	80-100
MATHEMATICS	Treatment Group Mean	41.67 (N=21)	52.14 (N=14)	76.67 (N=21)
	Non-Treatment Group Mean	43.79 (N=33)	57.24 (N=38)	77.02 (N=57)
		Low	Medium	High
	RANGE OF SCORES	30-60	65-75	80-100
SCIENCE	Treatment Group Mean	51.39 (N=18)	60.83 (N=24)	80.36 (N=14)
	Non-Treatment Group Mean	52.8 (N=36)	63.16 (N=49)	79.53 (N=43)

Data in the following tables show the results of the T-test analysis which were computed for the mathematics and science pretest scores that were achieved by the students who comprised the research population.

TABLE 5

RESULTS OF T-TEST ANALYSIS ON PRETEST SCORES FOR GRADE 7 PARTICIPANTS

Subjects	Name of Group	N	Mean	Standard Deviation	Standard Error	T-Value	Degree of Freedom	2-Tail Prob
MATHEMATICS	Treatment	67	68.209	12.423	1.518			
						0.97	153	0.332
	Non-treatment	88	70.227	13.085	1.395			
SCIENCE	Treatment	67	68.095	13.313	1.626			
						1.45	153	0.150
	Non-treatment	88	71.250	13.798	1.471			

Data in this table show that the 2-tail probability for mathematics was 0.332 and for science was 0.150, each result was more than 0.05 which was the level of significance. Because these two probabilities were higher than the level of significance, there was no significant difference between the grade 7 treatment and the non-treatment groups on their pretest scores that were achieved for the internal departmental tests in mathematics and science respectively.

In Table 6 there are data which show that the 2-tail probability for mathematics was 0.915 and for science was 0.322. These probabilities were in each case greater than 0.05 which was the level of significance. These data show that for the grade 8 treatment and

non-treatment groups, there was no significant difference on their pretest scores for the internal department tests for mathematics and science.

TABLE 6

RESULTS OF T-TEST ANALYSIS ON PRETEST SCORES FOR GRADE 8 PARTICIPANTS

Subjects	Name of Group	N	Mean	Standard Deviation	Standard Error	T-Value	Degree of Freedom	2-Tail Prob
MATHEMATICS	Treatment	53	68.773	12.086	1.660			
						0.11	163	0.915
	Non-treatment	112	68.526	14.498	1.370			
SCIENCE	Treatment	53	61.415	13.423	1.844			
						0.99	163	0.322
	Non-treatment	112	63.883	15.534	1.468			

TABLE 7

RESULTS OF T-TEST ANALYSIS ON PRETEST SCORES FOR GRADE 9 PARTICIPANTS

Subjects	Name of Group	N	Mean	Standard Deviation	Standard Error	T-Value	Degree of Freedom	2-Tail Prob
MATHEMATICS	Treatment	56	69.375	15.956	2.132			
						1.37	182	0.172
	Non-treatment	128	72.695	14.754	1.304			
SCIENCE	Treatment	56	65.357	15.576	2.081			
						2.04	182	0.043
	Non-treatment	128	70.117	14.149	1.251			

An analysis of the data presented in Table 7 shows that the 2-tail probability for mathematics was 0.172 which was higher than 0.05 which was established as the level of significance. These data show that there was no significant difference between the treatment and the non-treatment groups on their pretest scores they achieved on their grade 9 internal departmental mathematics test.

The data presented in Table 7 show for science that the 2-tail probability was 0.043, which was less than 0.05 level of significance. These data show that there was a significant difference between the treatment and the non-treatment groups on their pretest scores for grade 9 science.

POST-TEST DATA ANALYSIS

To analyze post-test scores, the ANOVA program from the SPSS package that was supplied to the researcher by the Division of Educational Research Service, Faculty of Education, University of Alberta was used.

POST-TEST SCORES

Post-test scores for students in the research population from grades 7 and 8 were the final scores that these students received on a grade specific internal departmental examination for mathematics and science. These examinations were written by these participants at the end of the 1981-82 school year.

The scores that were achieved by students who participated in the research were rounded off to multiples of five and recorded on 25A forms that were on file in the general office of the school.

DATA ANALYSIS PROCEDURE INVOLVING HYPOTHESES

In order to determine or establish if there were significant differences between the groups, the following procedure was used.

Although the six hypotheses in this study were written in the alternative form, the null form of the hypotheses was used for the statistical testing. The statistical statement of each hypothesis was:

H_0 : = 0

H_1 : = 0

where H_0 = null hypothesis

H_1 = alternative hypothesis

= variance of the treatment group

= variance of the non-treatment group

The level of significance was set a priori at 0.05. This computation was based on the procedure described by Ferguson. (1971 pp. 149-151) He stated that it was a common convention to adopt a level of significance of 0.05. (p. 149) The null hypothesis H_0 asserted that no difference existed between the variance of the treatment group and the non-treatment group. The alternative hypothesis H_1 asserted that the treatment and the non-treatment groups were drawn from populations having the same variance. If the null hypothesis (H_0) was rejected, the decision was that a difference existed between the variance of the treatment and the non-treatment groups.

The results obtained from the analysis of variance (ANOVA) by using the post-test data are listed in Table 8 for grades 7, 8 and 9 respectively.

TABLE 8

RESULTS OF THE ANALYSIS OF VARIANCE ON THE POST-TEST SCORES

GRADE	SUBJECT	SOURCE OF VARIATION	SUM OF SQUARES	DEGREE OF FREEDOM	MEAN SQUARE	F VALUE	SIGNIF. OF F
7	MATHEMATICS	Industrial Arts	455.918	1	455.918	3.289	0.072
	SCIENCE	Industrial Arts	219.392	1	219.392	1.713	0.193
8	MATHEMATICS	Industrial Arts	56.171	1	56.171	0.389	0.533
	SCIENCE	Industrial Arts	41.524	1	41.524	0.248	0.619
9	MATHEMATICS	Industrial Arts	186.875	1	186.875	0.995	0.320
	SCIENCE	Industrial Arts	35.753	1	35.753	0.328	0.567

The first hypothesis stated in the null is that the treatment group would not have a higher mean score than the non-treatment group on the grade 7 internal departmental mathematics examinations. The null hypothesis was accepted because the significance of F was 0.072 for grade 7 mathematics and this was greater than 0.05, the level of significance. The observation was made that there was no significant difference in performance between the treatment and the non-treatment groups on their post-test mathemtics scores of 1981-82. However, the data do appear to indicate that the science and industrial arts learning activities interaction was approaching a conventional level of significance (p 0.05).

The second hypothesis stated in the null is that the treatment group would not have a higher mean score than the non-treatment group on the grade 7 internal departmental examination in science. The null hypothesis was accepted because the significance of F was 0.193 for grade 7 science and this was greater than 0.05, the level of significance. Consequently, the observation was made that there was no significant difference in performance between the treatment and the non-treatment groups on their post-test science scores of 1981-82.

The third hypothesis written in the null is that the treatment group would not have a higher mean score than the non-treatment group on the grade 8 internal departmental examination in mathematics. The null hypothesis was accepted because the significance of F was 0.533 for grade 8 mathematics and this was greater than 0.05, the level of significance. Consequently, the observation was made that there was no significant difference in performance between the treatment and the non-treatment groups on their post-test mathematics scores of 1981-82.

The fourth hypothesis written in the null is that the treatment group would not have a higher mean score than the non-treatment group on the grade 8 internal departmental examination in science. The null hypothesis was accepted because the significance of F was 0.619 for grade 8 science and this was greater than 0.05, the level of significance. Consequently, the observation was made that there was no significant difference in performance between the treatment and the non-treatment groups on their post-test science scores of 1981-82.

The fifth hypothesis written in the null is that the treatment group would not have a higher mean score than the non-treatment group on the grade 9 departmental examination in mathematics. The null hypothesis

was accepted because the significance of F was 0.320 and that was greater than 0.05, the level of significance. Since that was the case, the observation was made that there was no significant difference in performance between the treatment and the non-treatment groups on their post-test mathematics scores of 1981-82.

Finally, the sixth hypothesis stated in the null is that the treatment group would not have a higher mean score than the non-treatment group on the grade 9 departmental examination in science. Again, the null hypothesis was accepted because the significance of F was 0.567 and that was greater than 0.05, the level of significance. Since that was the case, the observation was made that there was no significant difference in performance between the treatment and the non-treatment groups on their post-test science scores of 1981-82.

Although the analysis of variance (ANOVA) results indicated no significant difference between the treatment and the non-treatment groups, the investigation asserted a strong possibility of a Type II Error (that is, accepting the null hypothesis when it should be rejected). One possible explanation in support of the assertion may be that only a small number of students from the population of the school involved in the research got the opportunity to do the industrial arts course, and secondly, the individual variations in the post-test scores had a marked effect on the mean of these scores. This was an unavoidable aspect of the study which was pursued and the author recognizes it as a major limitation of this study, and probably of small group research in general. With reference to Type I and Type II errors, Mouly (1970) wrote:

> Actually, the only two ways in which both types of errors can be reduced simultaneously - and not at the expense of one another - would be by taking larger samples and/or by reducing the sampling variability by selecting a more restricted population or by relying on a tighter sampling design. (pp. 168-169)

SUMMARY

This chapter gave a review of the statistical analysis which was computed on the data collected during the research. It also included the results of the statistical analysis and some probable reasons for the Type II Error which was accepting the null hypothesis when it should be rejected.

CHAPTER IV

SUMMARY, OBSERVATIONS, CONCLUSIONS AND RECOMMENDATIONS

The first chapter of this report gave a detailed outline of the research design and the methodology that was used to bring this study to its conclusion. Contents of that chapter included the problem statement, the supporting objectives of the study, the rationale, operational definitions which were applicable to this research, a description of the research population which included both the treatment and the non-treatment groups. That chapter also incorporated a description of the research instruments, the hypotheses, the limitations that were applied to the investigation and the procedures which were used to collect and analyse data.

The second chapter presented an overview of the structure and functions of the Ad Hoc Committee on Industrial Arts; and its role in designing curricula for industrial arts, the category of subjects taught in a junior high school as well as a review of the mathematics, science and industrial arts programs of the research school. Content of that chapter also included a review of the research and literature which were related to this study.

The third chapter presented the statistical procedures that were used to analyse the data, and also gave the results of the analysis.

The fourth and final chapter of this thesis will be divided into three sections. The first section will contain a summary of the research methodology; the second section will include the observations and conclusion which resulted from the findings of this study; and the third section will be devoted to recommendation for further research.

THE PROBLEM

The research problem and supporting major objectives of this study were to determine if learning activities in industrial arts had an influence on the achievement test scores for mathematics and science, for junior high school students enrolled in industrial arts when compared to other junior high school students who were not enrolled in industrial arts but were enrolled in the same courses in mathematics and science.

In addition to the major objective of the study, it had the following supporting objectives: to determine if the learning activities in industrial arts that included mathematical and/or scientific concepts were realistic in quantity to reinforce these concepts for the core subjects; to determine if the kinds of industrial arts learning activities that purported to reinforce mathematical and scientific concepts will have to be expanded as a result of this study; and finally to determine if district or school designed "Achievement Tests" contained questions, problems or statements that were related to the contents of the two core subjects that were purported to be reinforced in an industrial arts learning environment.

Examples of problems encountered during industrial arts learning activities and which required the use of mathematical and or scientific concepts in order to resolve the problem, are found in other sections of this thesis.

THE POPULATION

The initial population of this study consisted of 168 grade 7 students, 214 grade 8 students; and 199 grade 9 students from a junior

high school located in Calgary and which was under the jurisdiction of the Calgary Board of Education. Transfers and missing marks reduced the population data used in the statistical analysis to 155 grade 7 students, 165 grade 8 students and 184 grade 9 students. With reference to the treatment and the non-treatment groups, the data was grouped in this manner. The grade 7 had 67 students in the treatment group and 88 in the non-treatment group. The grade 8 had 53 students in the treatment group and 112 in the non-treatment group. The grade 9 had 56 students in the treatment group and 128 in the non-treatment group.

RELATED RESEARCH

An information retrieval search of the ERIC data base and also a manual search of the standard indices for reporting the findings of educational research, were conducted by the researcher. A review of the research literature revealed that a number of master's theses and doctoral dissertations were completed at universities in Canada and in the United States. Some had a direct bearing on this study and reports to that effect were made in chapter 2 of this thesis. The results of these studies tended to support the problem being investigated in this study.

RELATED LITERATURE

The investigator reviewed a number of articles in educational magazines and also books which were written by educators who recognized the contributions that industrial arts learning activities can make to reinforce concepts found in the core subjects of mathematics and science. The American Council on Industrial Arts Teacher Education was

endeavouring to highlight the contributions that industrial arts learning activities could make in selected areas of education when they promoted the 1982 convention for industrial arts teachers and made the theme of that conference, "The Contributions of Industrial Arts to Selected Areas of Education." In the 31st Yearbook, 1982, Martin contributed an article entitled, Industrial Arts and its Contribution to the Education of the Gifted. In that article, Martin mentioned five characteristics of the industrial arts program which would develop personalized skills. One of the five was:

> Opportunities are made available for students to seek new experience; to test hypotheses by using tools, materials and equipment and to fill in gaps in knowledge, (eg. using wind tunnels, numerical controls, computers and forming processes in an experimental mode). (p. 74)

RESEARCH METHODOLOGY

The research instruments employed to collect data were grade specific internal departmental examinations in mathematics and science of the participating junior high school, and the grade 9 departmental examinations in mathematics and science, which were set and administered by the Calgary Board of Education.

The data from the research instruments were coded by the researcher and they were key-punched by personnel of the Division of Educational Research, Faculty of Education, University of Alberta. The T-Test and the ANOVA programs from the Statistical Package for the Social Sciences (SPSS) were used to analyse the pretest and the post-test data respectively.

MAJOR FINDINGS

The hypotheses which were established for this research were not supported by the data which were collected and statistically analysed. Table 9 lists the results of the study in relationship to the six hypotheses which are found on page 24 of this report.

TABLE 9

RESULTS OBTAINED FROM THE ANALYSIS OF VARIANCE (ANOVA) COMPUTED ON THE POST-TEST SCORES (1981-82)

Hypotheses	Significance of F	Null Hypotheses Rejected	Null Hypotheses Not Rejected
#1	0.072		x
#2	0.193		x
#3	0.553		x
#4	0.619		x
#5	0.320		x
#6	0.567		x

The hypotheses were written in the null form and in all cases the null hypotheses were not rejected under the level of significance 0.05, which was used. This revealed that there was no significant difference in the performance of the treatment and the non-treatment groups on their post-test scores for achievement tests in mathematics and science during the 1981-82 school year. However, for the #1 hypothesis, the signfiicance of F was 0.072 and the data did appear to indicate that the industrial arts learning activities interaction with the grade 7 mathematics was approaching the conventional level of significance (0.05) which was used for this investigation.

OBSERVATIONS

To the researcher, it was apparent that the research population of the participating junior high school were very cooperative. Although

some of the participants in the treatment group did not complete all the modules of the industrial arts course, the industrial arts learning activities in which they were involved were usually well done.

The researcher assisted students with the design and building of projects for their science assignments. For example, a student was assisted in the geometrical construction of a parabola and also the construction of a weiner roaster which used the parabolic dish to focus the sun's energy to cook the weiner. Basic mathematical concepts and also scientific concepts were applied during the construction of the project.

The principal and the researcher's colleagues on the staff of the participating junior high school, were most cooperative in supplying information or materials which were requested by the researcher.

The industrial arts consultant and personnel of the Program Evaluation and Research Department of the Calgary Board of Education expressed interest in the results of this investigation.

The research instrument had a number of weaknesses which were not anticipated by the researcher. Some of these are cited below.

(a) The use of some form of standardized test might have been more effective in collecting the research data which were to be analysed.

(b) During the industrial arts lesson periods, the researcher might not have made ample references to the mathematical and scientific concepts which were related to the respective industrial arts learning activities.

(c) Also, prior to the students writing the achievement tests, the researcher did not get the opportunity to review the examination questions to determine if the questions and problem statements had

mathematical and scientific concepts which were purported to be reinforced during industrial arts learning activities.

Perhaps some of these inadequacies limited the tendency to adequately achieve the major and supporting objectives of this study.

It might have been interesting to note how many students in the treatment group improved their scores on the post-tests, and to compare that with the number of students in the non-treatment group who improved their scores on the post-test.

Finally, the researcher gained first hand experience of the role of statistics as an aspect of the scientific method in research on the learning process.

CONCLUSION

At the outset of this study, it was hypothesized that students who were involved with industrial arts learning activities would have a higher mean score on their mathematics and science examinations. The data which were collected and analyzed did not support the hypotheses. Consequently, it did appear as if the industrial arts learning activities did not have a significant difference on the treatment group when it was compared with the non-treatment group.

The reasons for the results may be due to a number of limitations pertaining to the study. Some are:

The type of instrument which was selected to collect the research data.

The lack of inter-disciplinary co-ordination between the units taught in mathematics and science, and the learning activities which were performed in the industrial arts laboratory.

The unavoidable change of industrial arts teachers during the 1981-82 school year.

Inadequate sampling technique.

This investigative process brought into focus some of the problems which researchers should endeavour to minimize.

SUMMARY

The general objective of this study was to examine one of the objectives of industrial arts which is to provide an environment in which students can reinforce and apply academic disciplines. This culminated into the researcher's attempt to ascertain if students who do industrial arts simultaneously with mathematics and science achieve better in these academic subjects than students who are not involved in industrial arts, but who take the same courses in mathematics and science.

In the junior high school that participated in the research, a treatment and non-treatment group were established for grades 7, 8 and 9 respectively. The pretest and post-test data consisted of scores that research participants received on their first and last mathematics and science internal departmental or departmental examinations that were administered during the academic year 1981-82. The treatment was the industrial arts program prescribed for junior high schools by the Department of Education as group A option.

A T-Test was used to analyze the pretest scores to determine if there were any significant difference between the treatment and the non-treatment groups. Finally, an analysis of variance was done on the post-test scores to ascertain their relevance to the six stated

hypotheses.

The results indicated that an attempt to differentiate between the achievement of the respective groups of students on the scores made on the mathematics and science departmental examinations revealed no significant difference. The six hypotheses of this study were written in the null form and the null form of these hypotheses were accepted.

RECOMMENDATIONS

The findings and conclusions of this study have implications for prospective researchers who may wish to pursue a similar study. The following recommendation should be carefully considered:

Improve the sampling technique in order to obtain groups which were relatively homogeneous.

The grade 9 mathematics and science departmental examinations were the most valid measurement devices available. An attempt should be made to analyse the items of the mathematics and science examinations in general, to ascertain to what extent their concepts could be applied in an industrial arts laboratory.

The mathematics, science and industrial arts teachers should maintain liaison in order to be aware of the units which were being taught in their respective courses.

The types of industrial arts learning activities which were pursued in the industrial arts laboratory should be examined to determine if these activities do in fact reinforce concepts taught in mathematics and science courses. To accomplish this, there should be better liaison between the industrial arts teacher and the teacher of mathematics and science to identify these concepts.

Finally, further study of this problem is warranted if the effect of industrial arts learning activities on mathematics and science achievement is to be fully appreciated and if the objectives of industrial arts can be scrutinized through scientific research.

To conclude, it may be stated that the evolution and inclusion of industrial arts as an invaluable component of general education, has a prestigious historical background. Many philosophers and educators have expounded on the contribution that industrial arts activities can make to the overall educational development of a student. Consequently, along with the teachers of other subjects, the industrial arts teachers have a every important role to play in the educative process. If the teachers of industrial arts wish to maintain their credibility, it is incumbent upon them to maintain a constant review of their programs and to constantly upgrade their skills in order to keep abreast with the current trends in education, and to some extent anticipate what may be required for the future.

APPENDIX "A"

This Appendix contains a list of Option Courses which were available in the research school during the school year 1981-82.

BOB EDWARDS JUNIOR HIGH SCHOOL

1981 - 1982

OPTION COURSE SELECTION FORM

GRADE SEVEN

(Please Print)

Student's Name in Full _____

Present School _____

Present Grade _____

Home Phone Number _____

Sex (Please Circle) M F

For Office Use Only

It is absolutely essential that you make 3 choices or this registration is not valid and you will not be allocated options of your choice.

Options	Course No.	Choices		
		First Preference	Second Preference	Third Preference
"A" Full Year Options 2 points				
French	7610			
Band	7425			
Glee Club	7420			
Drama	7410			
Art	7400			
Industrial Arts	7590			
Home Economics	7570			
Mathematics (Basic)	7500			

Date _____

_____
Signature of Student

_____

BOB EDWARDS JUNIOR HIGH SCHOOL

1981 - 1982

OPTION COURSE SELECTION FORM

GRADE EIGHT

(Please Print)

Student's Name in Full _____

Present School _____

Present Grade _____

Home Phone Number _____

Sex (Please Circle) M F

For Office Use Only

It is absolutely essential that you make 3 choices or this registration is not valid and you will not be allocated options of your choice.

Options	Course No.	Choices: First Preference	Second Preference	Third Preference
"A" Full Year Options(2 points)				
French	8610			
Band	8425			
Drama	8410			
Art	8400			
Industrial Arts	8590			
Home Economics	8570			
Science	8550			
"B" One-Semester Options(1 point)				
Consumer Education	8702			
Calligraphy	8401			
Film Making	8402			
Linguistics	8615			

Date _____

_____
Signature of Student

_____
Signature of Parent(s)

BOB EDWARDS JUNIOR HIGH SCHOOL

1981 - 1982

OPTION COURSE SELECTION FORM

GRADE NINE

(Please Print)

Student's Name in Full _____

Present School _____

Present Grade _____

Home Phone Number _____

Sex (Please Circle) M F

For Office Use Only

It is absolutely essential that you make 3 choices or this registration is not valid and you will not be allocated options of your choice.

Options	Course No.	Choices		
		First Preference	Second Preference	Third Preference
"A" Full Year Options (2 points)				
French	9610			
Band	9425			
Drama	9410			
Jazz - History and Appreciation	9419			
Art	9400			
Industrial Arts	9590			
Science	9550			
Home Economics	9570			
"B" One-Semester Options (1 point)				
Consumer Education	9702			
History	9500			
Junior Achievement	9110			

Date _____

_____
Signature of Student

_____
Signature of Parent(s)

APPENDIX "B"

In this Appendix can be found
mathematical and scientific concepts
that were an integral part of the learning activities
in the industrial arts laboratory.

MATHEMATICS

1. How many pieces of 6 mm thick acrylic plastic 3.5 cm square were required to make one pair of salt and pepper shakers 6 cm high. For the sanding and polishing of each shaker, 2 mm waste was allowed.

Mathematics involved - Concepts: linear measurement, decimal, fraction, Functions: addition, subtraction, division, multiplication.

2. A piece of round aluminum turned on the metal lathe was measured by using a micrometer. The diameter was found to be 18.86 mm. Calculate how much material was to be cut to obtain a finished diameter of 18.50 mm.

Mathematics involved - Concepts: diameter

Functions: subtraction, division.

3. Three dry cells (each 1.5 volt) were connected in series. What was calculated to be the total voltage?

Mathematics involved - Functions: addition or multiplication.

4. An input gear had 25 teeth and the output gear had 50 teeth. What was the mechanical advantage of the gear system?

Mathematics involved - Concepts: ratio

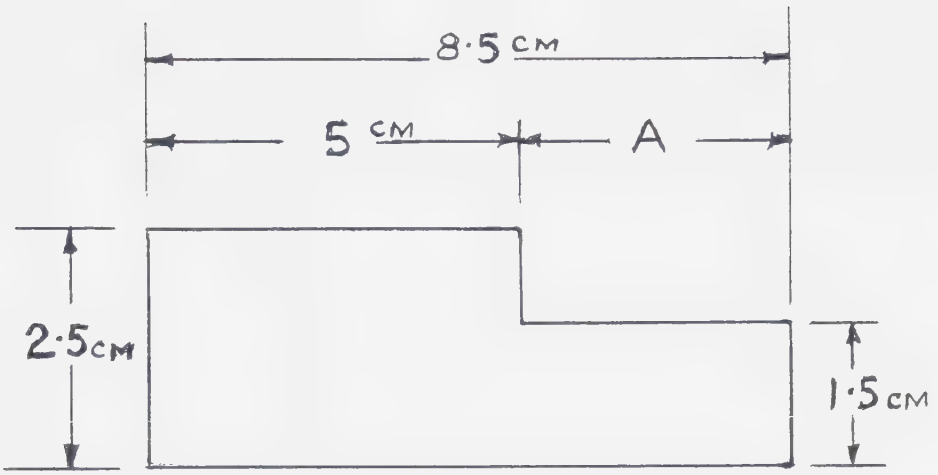
Functions: division

5. The developing solution for photographic paper was mixed with water in the proportion of one part developer to two parts of water at $20^{o}C$. If 10 cm^{3} of developer was poured into the tray, how much water was added to make the solution for the photographic paper?

Mathematics involved - Concepts: ratio

Functions: multiplication or division

BLUE PRINT READING



What was the length of "A"?

Mathematics involved - Concepts: equation, linear measurement

Functions: subtraction

SCIENCE

The following are examples of how scientific principles, laws or theories were applied or observed during industrial arts learning activities.

1. A film entitled "Cutting Tools" was viewed by the students and these tools were demonstrated by the teacher.
Scientific principle involved - wedges, inclined plane.

2. The researcher demonstrated one of many combining processes by using the soldering process to join non-ferrous metals.
Scientific principle involved - heat and state of matter, adhesion, oxidation, color relative to the temperature of hot materials.

3. Holding materials with vises and clamps were very important procedures in the industrial arts laboratory and were quite frequently performed by students. A safety procedure was holding material firmly in a vise which was clamped to the table of the drill press while the material was being drilled.
Scientific principle involved - screw as a simple machine, lever, mechanical advantage, inclined plane.

4. Students activities involved the use of the claw hammer or pincers to remove nails from boards. These activities also involved the use of a snip or shear to cut tinplate.
Scientific principle involved - levers, mechanical advantage.

5. A subject, a source of light, a camera and photosensitive film were required by a student who took a series of photographs. The film was developed.

Scientific principle involved - light and refraction, chemical change.

6. The students used a reproducing or wax pencil to draw or write on an offset master. The offset master was treated with offset etch and then it was attached to the offset duplicator. During the printing process, the offset master was treated with fountain solution and ink was applied to the master to produce copy.

Scientific principle involved - oil does not mix with water. Adhesion. Evaporation.

APPENDIX "C"

A sample blue print grid which test designers from the Program Research and Evaluation Division of the Calgary School Board, used to determine the number of questions for each mathematics topic of the grade 9 mathematics program of study.

APPENDIX 'C'

BLUEPRINT OF GRADE IX MATHEMATICS TEST, 1980

Objectives	TOPIC OR CONTENT AREA							
	NUMBER SYSTEMS			Ratio & Proportion	Measurement & Geometry	Graphing	Algebra	% of Items
	Whole	Integers	Rationals					
Open Search								0-10
Application								15-25
Comprehension								40-50
Knowledge & Computation								20-30
% of Items	6	6	14	9	25	5	35	100

APPENDIX "D"

A sample blue print grid which test designers from the Program Research and Evaluation Division of the Calgary School Board, used to determine the number of questions for each science topic of the grade 9 science program of study.

APPENDIX 'D'

BLUEPRINT OF GRADE IX SCIENCE TEST, 1982

OBJECTIVES	TOPIC OR CONTENT AREA						EMPHASIS %
	MEASUREMENT OF MATTER 9.1	KINETIC MOLECULAR THEORY 9.2	HEAT AND TEMPERATURE 9.3	ENERGY 9.4	CHEMISTRY OF MATTER 9.5	GENERAL PROCESS SKILLS 9.6	
Open Search (Analysis, Synthesis) 4.0 - 6.0							10-15
Application 3.0							25-35
Comprehension 2.0							35-40
Knowledge 1.0							15-25
Emphasis	15	25	15	5	10	30	100

APPENDIX "E"

Sample sheet of the letter which gave permission to the researcher to conduct the study in the schools of the Calgary Board of Education

Our File No.

Calgary Board of Education

Office of the Chief Superintendent

December 3, 1980

Lloyd S. Robinson
Bob Edwards Junior High School

RE: THE EDUCATIONAL INFLUENCE OF INDUSTRIAL ARTS ON STUDENTS WHO ARE TAKING IT SIMULTANEOUSLY WITH MATHEMATICS AND SCIENCE

Please be advised that permission to conduct your study in the schools of the Calgary Board of Education has been granted by this office. The permission granted only indicates that we have no objection to the study you propose. Final decision to participate in the study rests with the principals and teachers of the schools selected. Upon completion of your study, a copy of the results should be forwarded to the principals of the schools involved and Program Evaluation section of the Chief Superintendent's office.

May we wish you every success in your study.

J. VAN DER LEE - SUPERVISOR
(RESEARCH & TESTING)
PROGRAM EVALUATION

E. H. ELKINS - ACTING DEPUTY
SUPERINTENDENT
DIVISION OF INSTRUCTIONAL SERVICES

Education Centre Building, 515 Macleod Trail S.E.
Calgary, Alberta T2G 2L8, Telephone: 288-8100 (Area Code 403)

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